July 20, 1929 A McGraw-Hill Publication 20 Cents per Copy

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AVIATION

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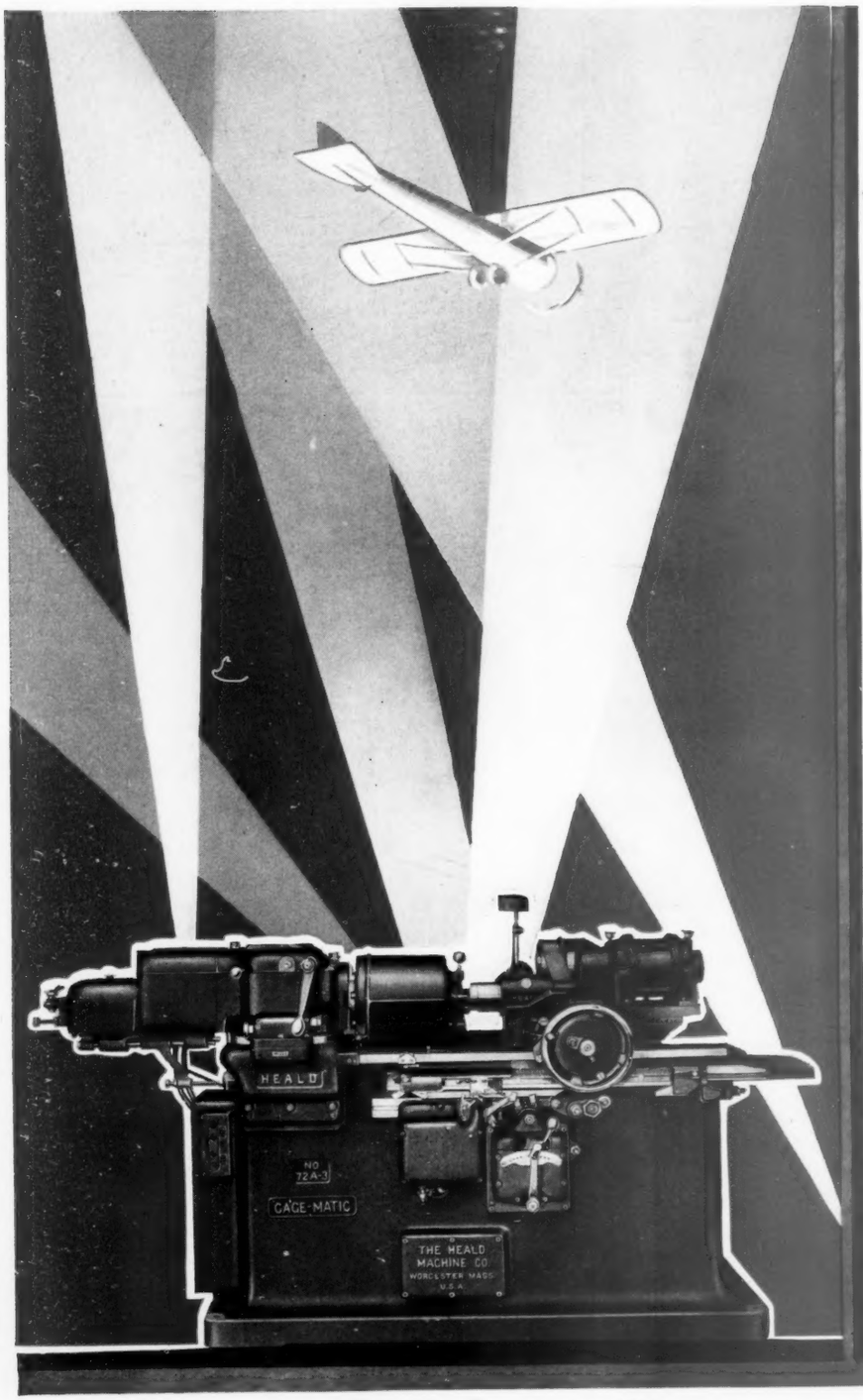
SPECIAL FEATURES

Sales Factors **IN THE CABIN PLANE MARKET**

Lumber Built **AIRPLANE HANGARS**

AERONAUTICAL *Engineering* **SECTION**



An

Airplane engine or any other product is no better than the degree of accuracy with which each part is manufactured.

This is particularly true of the all moving parts.

Manufacturers of airplane engines have made an intensive study and investigation under actual operating conditions as to the best equipment for finishing the holes in such parts as cylinders, gears, bushings, valves, etc., with the results that they have unhesitatingly chosen Heald Automatics.

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Quality Can Best Be Produced by Quality

The Heald Machine Co., Worcester, Mass., U.S.A.

HEALD

AVIATION, July 20, 1929. Vol. No. 27, No. 3. Published weekly. McGraw-Hill Publishing Company, Inc., New York, N. Y. Domestic $4.00 per year; Canada $5.00. All other countries $6.00; 20 cents a copy. Entered as second-class matter, July 27, 1928, at the post office at New York, N. Y., under the act of March 3, 1879. Printed in U.S.A.

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Gypsy Moths hold a number of international records, and everywhere they have proved themselves dependable light planes.

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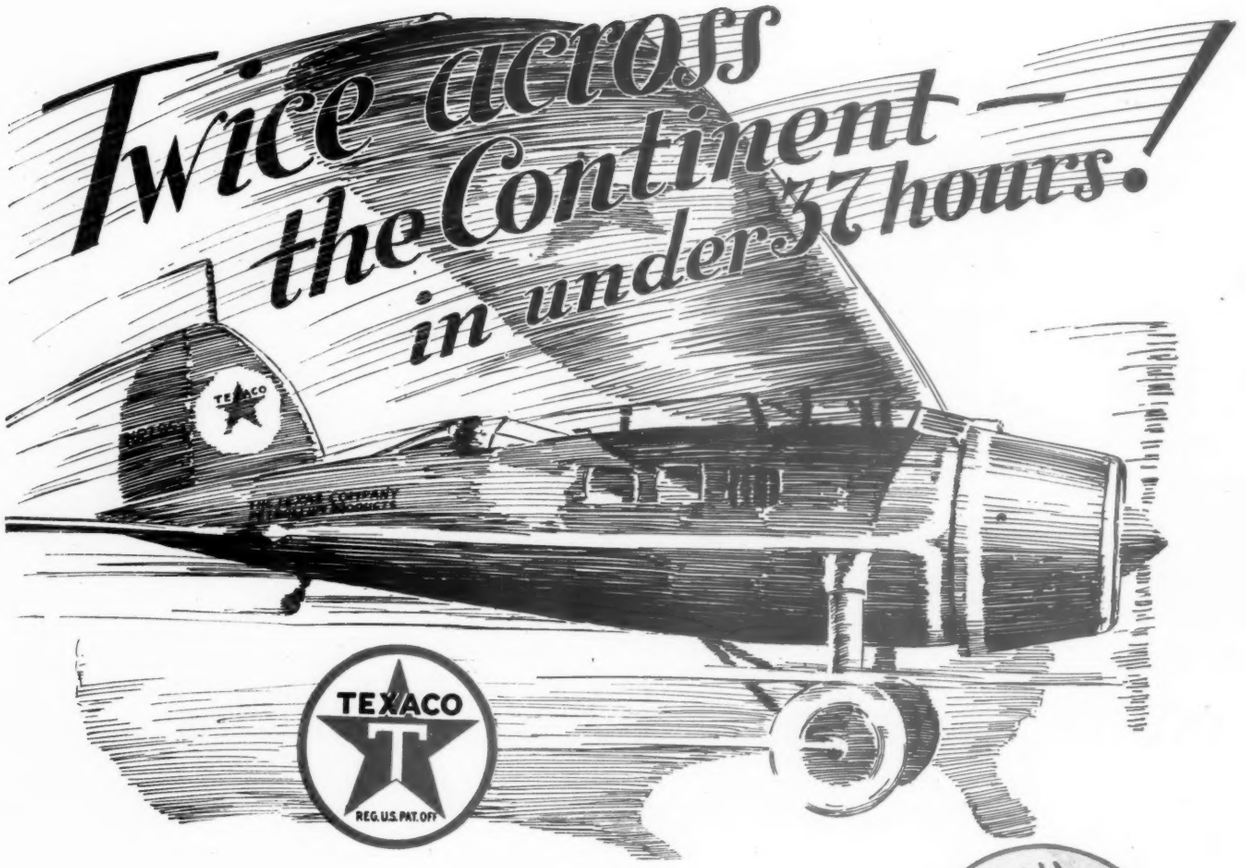

WHEN Captain Frank M. Hawks hurled the TEXACO Number 5 from Los Angeles to New York AND BACK in 36 hours, 48 minutes, 48 seconds, he smashed all transcontinental records. Modestly discounting his own iron nerve and navigating skill, he credited his succes to "a fine ship, plus good gasoline and oil." As on his other record-breaking flights, Captain Hawks used TEXACO Aviation Gasoline and TEXACO Airplane Oil.

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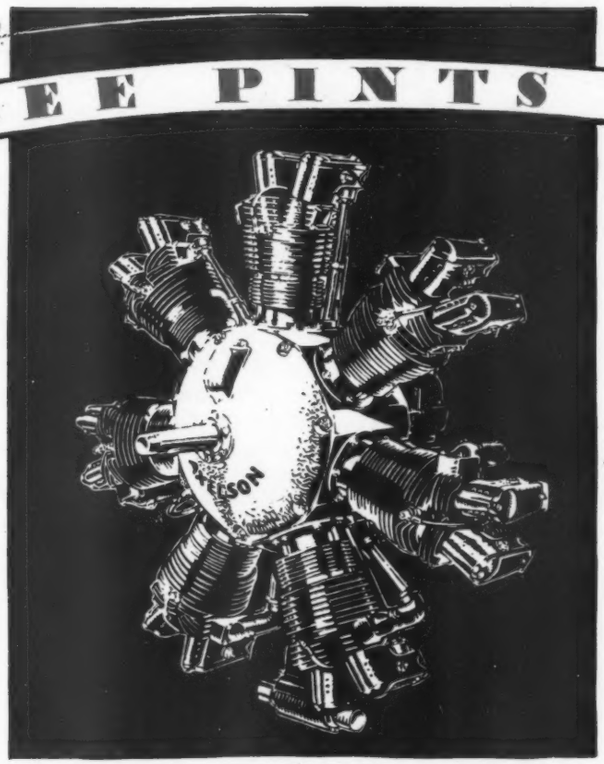

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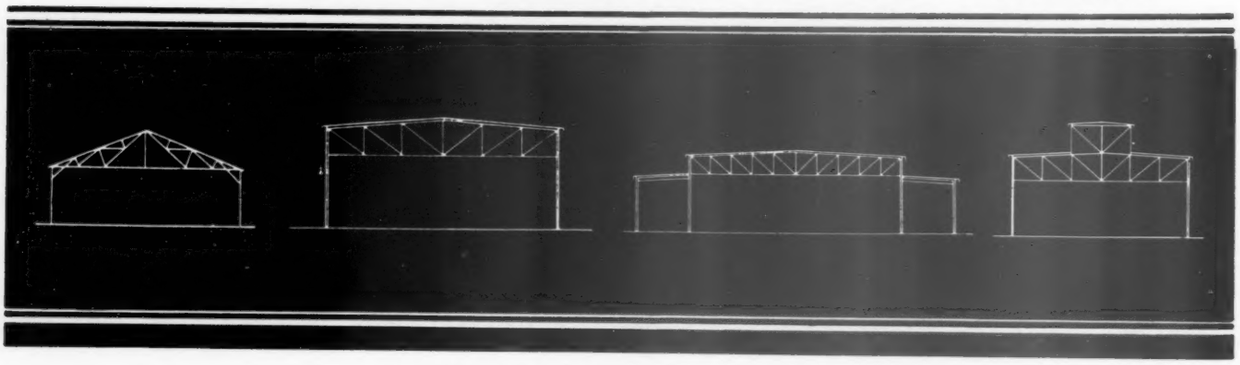

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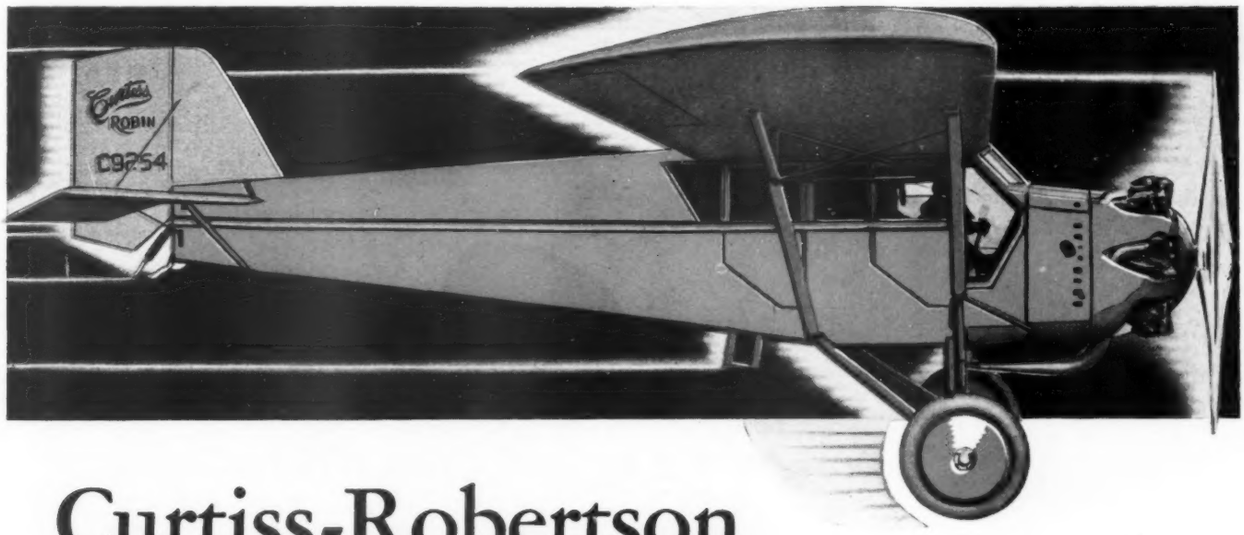

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The *safest* light plane in the world

THE OUTSTANDING SPORT AND

PUT the Whittelsey Avian through its paces. Not with the conscious effort of a "show-off" but with the supreme ease of a born aristocrat this famous light plane responds to every wish and whim of its pilot.

From the moment you give it the gun until it floats into a gentle three-point landing, propeller still, stick dead, the Avian gives a flying performance that is a happy combination of stability, ease-of-handling, speed, durability and safety.

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1. You can't take it off the front porch. But no light plane is quicker to lift its nose into the air and leave the ground behind. By the same token, you can land the Avian in any pasture of decent size.

And from take-off to landing the Avian will give you the most comfortable, satisfying flight.

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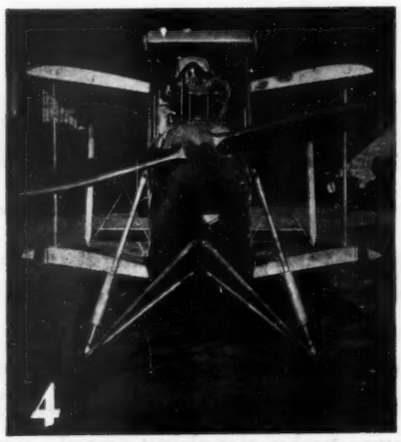

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Lockheed Air Express, Approved Type Certificate No. 102

LOCKHEED

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Passengers Must Be Flown in Safety

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Phillips Aviation Gasoline, now in its third successful year of manufacture, is characterized by—*easy starting; more engine revolutions per minute; more economy of operation; more power;* all because of BETTER DISTRIBUTION TO ALL CYLINDERS.

Phillips Aviation Gasoline is used by air mail contractors, and by a steadily increasing number of passenger transport lines.

Available at many airports.

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PHILLIPS PETROLEUM CO.
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NATURAL GASOLINE FOR CONTROLLED VOLATILITY

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Navy Department
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Climax Engineering Co.
The Four Wheel Drive Auto Co.
Graham Bros.
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Schramm, Inc.
Selden Truck Co.
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These firms KNOW that Stromberg superior performance is the result of the highest type of carburetion engineering, the finest workmanship, the best materials procurable.

They recognize real merit and are willing to pay for it.

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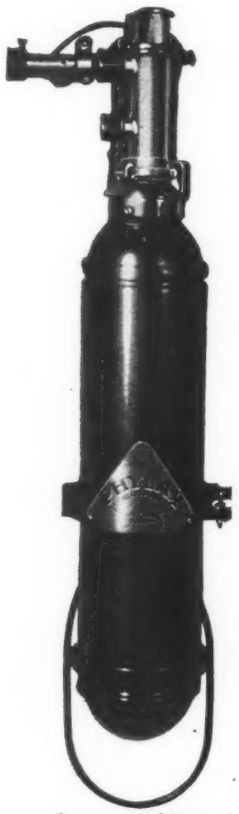

Operates on multi-motored planes as well as those with single power plants.

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Leave This Invisible Passenger Behind...

No fire hazard rides the plane equipped with PHY-LAX—the amazing fire extinguishing system which instantly smothers the first licking flame.

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This chemical is supplied through copper tubing from a cylinder mounted in the cockpit, and operates automatically, as well as by hand pump when needed. No fire, however hot or quick, can withstand for a moment the instantaneous effectiveness of this fluid.

There is a PHY-LAX installation for every type of motor and plane—at the uniform, moderate price of $70 complete. Indeed, the lowest cost insurance for the highest form of absolute fire protection. Full particulars will be mailed on request.

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3. Weight, including tubing, only 12½ lbs. System is installed in new construction or can be installed in planes already built.
4. Provides positive fire protection for the motor, fuselage, cabin and wings.
5. Capacity adequate for planes of largest size.
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8. Fire extinguishing chemical used, smothers fire instantly.
9. Sprinkler leads direct to strategic points of each motor, including carburetor and oil sump.
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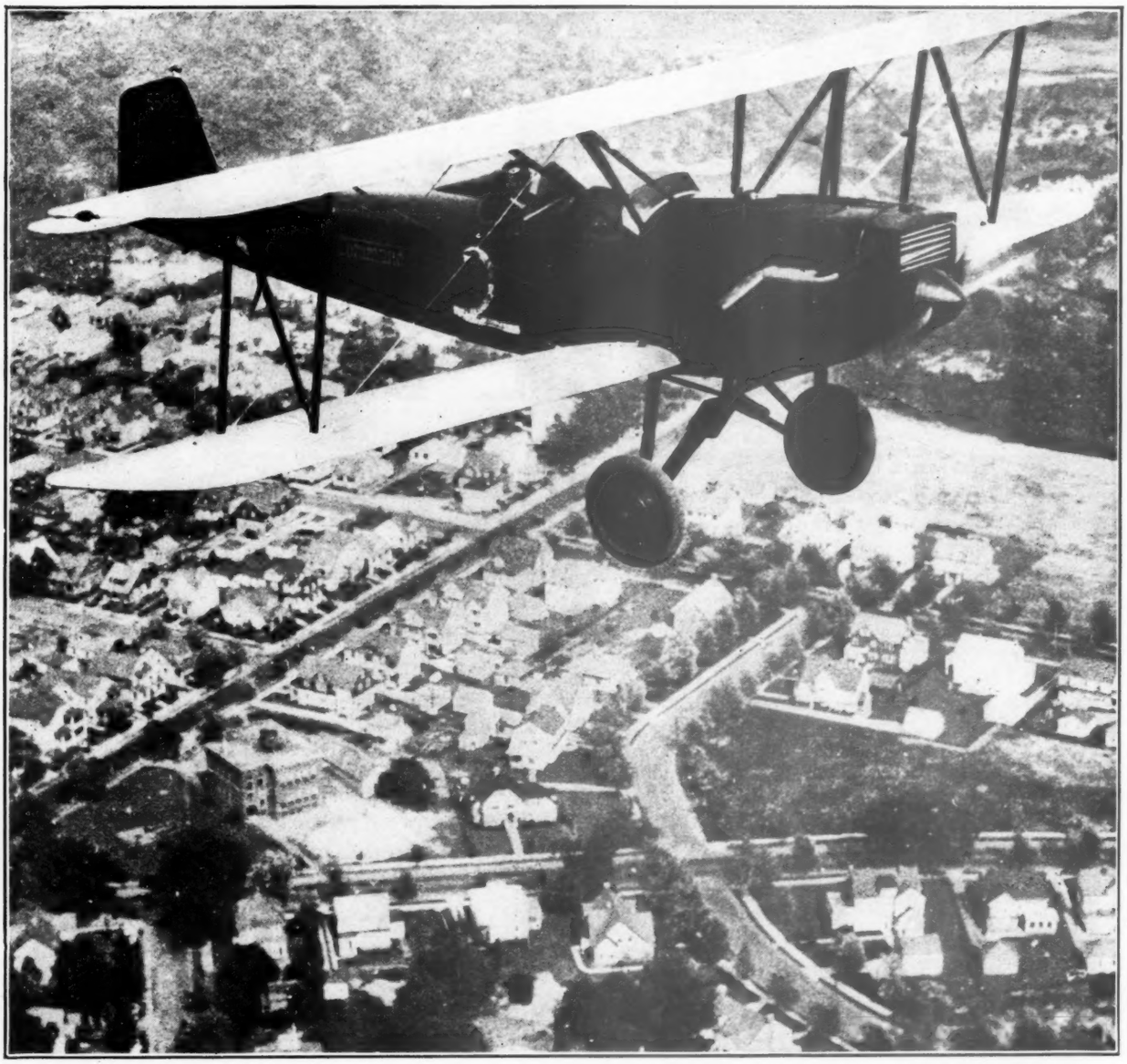

LOWELL BAYLES, *chief pilot of Eastern States Aircraft Corporation, flying over Springfield, Mass., in his Socony powered Command-Aire.*

SOCONY IS "OFFICIAL" AT SPRINGFIELD AIRPORT

ELEVEN planes regularly stationed at the Springfield, Mass., Airport use Socony products. The fact that Socony Aviation Gasoline has been the official gasoline ever since the port was opened a year ago speaks for its quality.

Socony Aviation Gasoline and Aircraft Oils are readily available at airports throughout New York and New England. Uniform in quality, they are designed for flying under the most exacting conditions.

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STANDARD OIL COMPANY OF NEW YORK

Safe Haven

Knowing pilots spot the sign and pick out the airport where Naturaline is sold. It is assurance of the best accommodation and the best fuel.

Naturaline distribution is now widespread. During the past year the Naturaline plane, a Buhl Air Sedan, has flown the air ways of America giving the franchise that provides for proper distribution of this outstanding fuel.

"Where can I get it" is no longer the question. "Take on Naturaline, you'll get off quicker, fly faster and find it better" is advice now given by experienced pilots.

Many of the outstanding mail lines, transport companies and airport operators use Naturaline exclusively because of the following advantages: It starts quicker. Fuel consumption is less. Its power output is greater. The improved motor performance is marked. It is lighter in weight. It reduces the cost of motor over-haul.

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DAVIS AIRCRAFT

DAVIS has combined in a compact, economical, two-place monoplane the inherent stability, performance and flying characteristics previously found only in larger and heavier planes.

It is a fact that the unusual and exclusive wing design of the Davis V-3 Monoplane achieves a degree of inherent stability—even in rough weather—far beyond previous light plane experience.

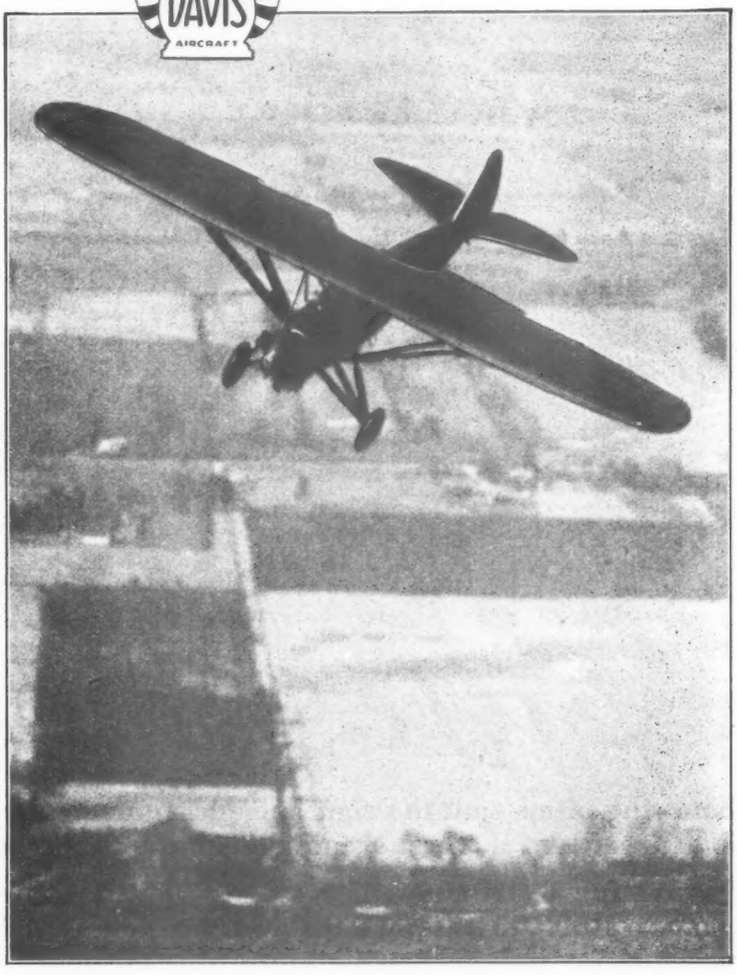
It is a *modern* plane *in every detail*—so soundly engineered, and so sturdily constructed that operating and maintenance costs are reduced to the minimum.

Read the performance data summarized below. Then you will understand (as well as anyone can until they have actually taken the stick) why the Davis V-3 Monoplane is an ideal plane for student training, and for the man who wants a plane for personal use. Write for complete information.

$2965
Flyaway at field
Complete with LeBlond 60 H.P. Radial Engine

Many rich territories are still open. Responsible dealers are invited to write for complete details of the Davis Franchise.

DAVIS AIRCRAFT CORPORATION
Richmond, Indiana



DAVIS V-3 MONOPLANE

PERFORMANCE (Actual)

Service Ceiling	10,000 feet
High Speed	95 M. P. H.
Landing Speed	38 M. P. H.
Cruising Speed	80 M. P. H.
Climb	700 ft. per minute
Fuel Consumption at Cruising Speed	4½ gallons per hour
Cruising Range	350-400 miles

A TWO-PLACE HIGH-WING MONOPLANE—"THE AMERICAN MOTH"

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The Oldest American Aeronautical Magazine

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SCINTILLA
AIRCRAFT MAGNETOS

have again proved their stamina in this record-making flight emphasizing more than ever their *dependability*.

The record of the gruelling flight of the "Angeleno" speaks convincingly of the thoroughness with which each Scintilla Magneto is inspected and tested before leaving the plant.

They are selected because of their:
Dependability—Simplicity
Accessibility

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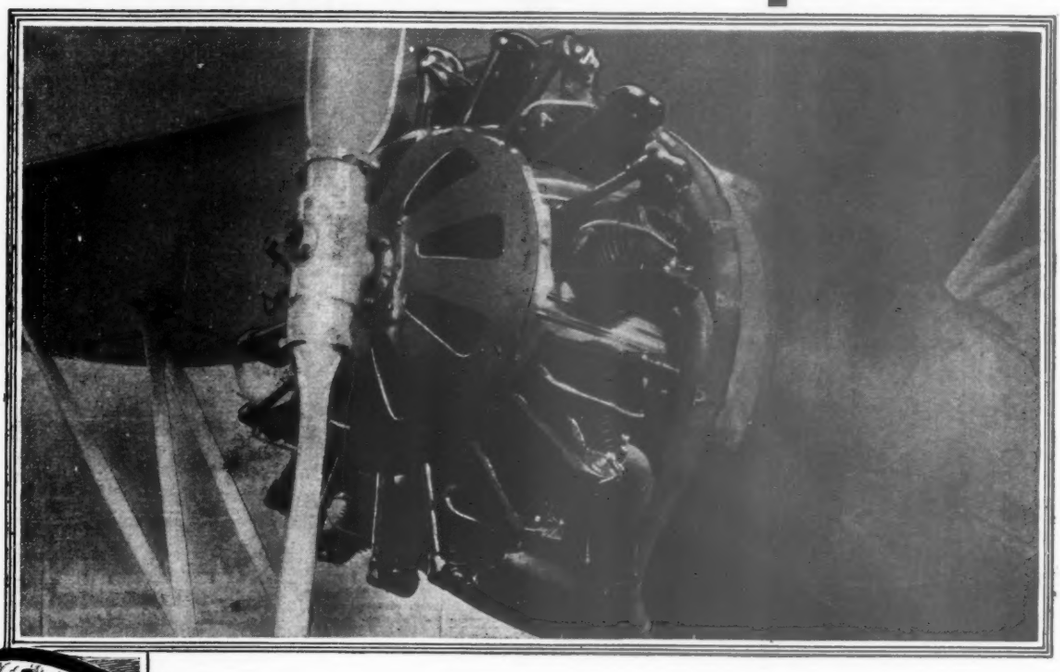

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AVIATION

THE OLDEST AMERICAN AERONAUTICAL MAGAZINE

A McGRAW-HILL PUBLICATION . . . ESTABLISHED 1916

EDWARD P. WARNER, *Editor*

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Air Regulation

THE AIR COMMERCE ACT of 1926 was the first definite step in the Federal regulation of aircraft and aircraft operation in these United States, and although there are those who have wailed to the skies that the industry is being stifled with "over-regulation," had it not been for that Act we would today undoubtedly be in an extremely hectic state of affairs and faced with peril of stagnation in the industry.

It is quite possible that there are existing air regulations that annoy the major portion of the industry, and which were primarily enacted to be aimed at the erring few. No doubt there are provisions that could with advantage, be modified or stricken from the books. Yet, it should be realized that there was no precedent for aeronautical law and regulation, and that it has been necessary to proceed by trial.

Taking all in all, the Regulations Division of the Aeronautics Branch has performed an exceptionally fine job in the time allowed. That job is not finished, nor will it ever be finished. Practically each new dawn brings need of regulation for some new or entirely changed phase of aeronautics. As an example, the recent inauguration of trans-continental air-rail service has brought up the problem of regulation covering the operation of other aircraft over the route of the coast-to-coast service. Where is there a precedent upon which regulation can be based to determine air space rights for the airline, similar to railroad track boundaries? Should the airline or the individual state aviation committee set the landing fee figure for planes landing on the airlines's airports, particularly if they happen to be leased from or donated by the local municipality?

There are indeed, a hundred and one regulations that would have to be enacted and amended before all the rough edges could be rubbed away. We shall continue to hear complaint after complaint, many of which will be completely justified. If ground for them all could be removed we would be eternally grateful to the "miracle man," but unfortunately, in air regulation as in many other things, the millennium is still far away. While awaiting it, our best recourse is to give the regulating bodies the complete cooperation that they rightfully deserve. We reserve the right to disagree with them. We shall criticise from time to time, and we believe that they welcome criticism based on a desire to help. But instead of selecting which regulations we shall follow and which we shall not, let us cooperate loyally in carrying out the entire lot until better substitutes are brought to light. Too much regulation may indeed stifle progress, and too little regulation may bring about an even more disastrous result, but haphazard compliance with regulations may be worse than no regulation at all.

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Mendell and Reinhart

WE HAVE previously expressed the opinion that the technical profit from duration flights with refueling, and from various other attempts at record-breaking, would be much increased if the builders of planes and engines would conduct them themselves. We have declared the view that the aircraft industry has little to gain from a wave of enthusiasm for refueling and an indefinite multiplication of such flights.

We have no desire to modify those expressions, but they do not in the least detract from our admiration for the really remarkable performance of the Angeleno and her two pilots. It would be impossible to let that pass without comment.

The flight sets up one of those figures which serve as landmarks in the history of record-making. Like the first man to fly at three hundred miles an hour and the first one to reach (many years ago) an altitude of ten thousand feet, the team which first remained in the air for ten unbroken days and nights is assured of lasting fame.

The engine more than confirmed the expectations justified by the past record of the type. Even 246 hours of flying did not develop the full limits of its capacity. Its performance is a dramatic evidence of the progress

that has been made since, only a dozen years ago, fifty hours of intermittent running between overhauls was all that could be expected. It is a tribute to the courage, persistence, and far-flung ambition of the engine designers and builders and the officers of the naval and military services who insisted, not long after the war, that power-plant durability was not merely to be increased by short and occasional steps but was to be doubled and quadrupled without delay.

The airplane did its part, and when it finally gave way it was only the abnormal conditions of refueling that were responsible. It is the crew's own share in the record, however, that is most astonishing, for we have learned to count on great things from engines and planes. To spend 246 consecutive hours behind a roaring engine, half of it at the controls, the time off duty repeatedly broken by the anxious business of refueling and taking on supplies—that constitutes a real test of human endurance. As usual the human organism showed itself possessed of unanticipated resources.

Nothing is further from our minds than to discourage record-breaking. We thoroughly believe in records as an index of progress and as trade publicity. We do, however, suggest that any group planning to break this one should devote themselves to the perfection in detail, with much preliminary practise, of an improved refueling technique, and that they should start only under conditions justifying a reasonable expectation of being able to remain aloft for at least two weeks.

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"First Stop San Francisco!"

PASSENGERS upon air lines are not eager to participate in breaking records. The technical details of the process by which they reach their destination matter little to them. They want to travel safely, speedily, economically, and comfortably, and most of them want nothing more.

These essentials are best combined by breaking the journey, where the nature of the route flown permits, into stages of from two to four hundred, or certainly not more than five hundred, miles in length. Upon that point theory and practical experience are fully agreed. Beyond that length of non-stop run, the sacrifice of pay load in favor of fuel cuts into economy so badly that the saving of time cannot compensate.

The idea of the non-stop flight exerts a curious attraction. There is something romantic about the notion of carrying ordinary passengers from the Atlantic to the Pacific coast, or from North to South America without any halt. But romantic appeal is an unstable foundation for the transportation enterprise. Economy and efficiency are much to be preferred as cornerstones.

There are some areas in which eight hundred or a thousand miles must be covered without stop because of impossible local conditions. There are long over-water routes without possible landing places upon which it is desirable to provide service. In the vast majority of cases, however, it is perfectly feasible to break the journey at intervals of three or four hours. To do so is more economical. It is actually pleasanter for the passengers, who have a chance to get out and move about. It lengthens the total time of the journey by a few minutes at most. To fail to take advantage of such opportunities for intermediate landings is sheer waste.

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An Air Mail Anniversary

JUST ABOUT three years ago this time, the last of the original group of private air mail contractors were getting under way—a very advanced experiment in the field of air transportation. It was such an experimental effort, in spite of facts and figures derived from Post-Office Department operation of the transcontinental trunk line, that the predominant emotion as each new line was dedicated was mostly tenacious faith.

During some of the lean periods which followed, this faith was put to severe tests. Now that these lines are paying their way or are about ready to jump over to the blue side of the ledger from the red side, and inasmuch as many other operators subsequently have joined the ranks of the original group, it is obvious that faith has been triumphant.

This is not to say that launching these so-called feeder lines was a leap in the dark, a bit of inexperienced blind flying, so to speak. Had this been so a "crash" would have been the logical outcome. In most cases confidence in the air mail contract system was buttressed by experience in military or independent flying and the precedents to be derived from operations of the old transcontinental.

And to this may be added one of the deepest secrets for the auspicious record of the three years—the willingness on the part of the operators to learn well the lessons taught by the days and nights of feeder line development, which included episodes often well rating classification as heartrending. Carrying the mail on schedule over airways in various stages of perfection and in difficult weather, produced innumerable new problems and the solution called for considerable adaptation.

It is all part of the absorbing history of air mail, how types of aircraft have been evolved to perform the specific job assigned, how night flying and operation through severe handicaps of unfavorable weather have been advanced, how radio communications and direction apparatus have been brought into use, and how the public has gradually been "sold" the idea of the service.

Not the least of the difficulties was the last. It constituted a new departure for aviation, and the degree to which it has been conquered is one of the most important factors contributing to the present status of the lines. In fact, public patronage is essential, and the

groundwork in that direction became as important as the operations in the air. In convincing the public that it should use the air mail, the companies achieved an invaluable national by-product, which is being designated as "air-mindedness."

As the first three years are being rounded out we see the original twelve contract mail routes operating in 1926 extended to twenty-four. From a daily mileage of about 16,000 mi., operations have been extended to about 36,000 mi. daily, the greater part being flown at night. So successful has the private contract system been that even the transcontinental run has been turned over to civilian companies, and its schedule has been doubled.

The story, of course, is still in its early chapters. Standing on their newly acquired foundation of air mail experience, most of the companies are planning for, or already are developing, air passenger service,—the ultimate goal of air transport. The "experiment" has become an indispensable element in the economic life of the country, and it sweeps onward into the fourth year of its existence still motivated by faith, but faith now stronger and much more widely shared.

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Steel

THERE ARE national fads and fancies in aircraft design. The British government for years could see no virtue in welded steel fuselages. One country rejects the idea of the cantilever monoplane, while another will have nothing else. One is quick to adopt the air-cooled engine, another resists the innovation to the last gasp.

In the United States many manufacturers still cling to wooden wing structure. Others, as yet fewer in number but making up in enthusiasm for their choice what they may lack in volume, have turned wholeheartedly to duralumin. A very small group indeed have experimented with the idea of welding up spars of alloy steel. Not a single one has made serious trial of a form of construction that has become almost universal in Great Britain in the last few years, and that is being ably described by Mr. W. H. Sayers in a series of articles of which the second appears in the current Aeronautical Engineering Section,—the assembly of spars out of thin strips of steel of very high strength.

There is no evidence, from a comparison of the weights and performances of British planes with those of other nationalities, that steel strip possesses any general inherent advantage over the best of the alternative materials of spar construction. There is, however, every reason to believe that for certain types of design and certain wing sections the steel strip can prove itself superior to all its rivals, as for other particular cases it is definitely inferior. Its possibilities should be explored in America. It has made a good enough record in Europe to make it undesirable that we continue to depend solely on second-hand evidence regarding its capacities.

The value of a constructional material cannot be judged solely in terms of weight for a given strength. Theory tells an incomplete story. The special weakness of strip steel as a spar material is its extreme sensitiveness to local damage. A tiny dent may be responsible for secondary failure at far below the intended strength. Another handicap under which it works is the relative, and often extreme, complexity of fitting design.

There are counterbalancing practical advantages. Spars perfectly constant in form throughout their length, assembled with rivets placed in straight lines on a constant spacing, are ideally adapted for efficient production in really large quantities. Whereas welding inevitably requires the skill and judgment of a trained operator, the assembly of riveted spars can be made virtually automatic, as the riveting of the seams in the metal-clad airship now building near Detroit already has been. The workman has only to keep the material feeding truly into the machine.

The introduction of rust-proof steels heightens the interest of steel wing construction. Resistance to corrosion is a key point in the choice of metals for aircraft service. Twenty years ago "stainless" steel was hardly even dreamed of. It has now gained so important a place, thanks to the researches of Sir Robert Hadfield and the Krupp firm and others here and abroad, that it will play a large part in the highest building now under construction in New York. Not yet employed in regular aircraft service, experiments on its fabrication have been carried to the point of making it quite practicable for spar work on which there is no welding to be done.

The American aircraft industry, taken as a whole, cannot afford to overlook any methods or materials which have been so successful elsewhere as to encourage their continued use by competent constructors. To turn to steel strip spars at the expense of abandoning present practices would be worse than foolish. It is a much less serious error, but still it is unwise to neglect their possibilities entirely.

BEGINNING with this issue, the editorial text pages of AVIATION *and the advertising pages will be separately numbered. The advertising pages will begin at 1 in each issue, while the numbers of the text pages will pick up where the text ended in the preceding issue. Page 162 was the last page of text in the July 13th issue and the first page of this issue is therefore 163.*

Those readers who bind their copies of AVIATION *will welcome this change as it will enable them to bind compactly only the editorial text pages of the magazine and will afford an unbroken sequence of page numbers throughout an entire volume.*

Sales Factors IN THE CABIN PLANE MARKET

By SAM BREDER
Sales Manager, Lockheed Aircraft Company

FOLLOWING the recent popular wave of enthusiasm for flying, aircraft manufacturers have performed wonders in placing new plane designs on a quantity production basis in an attempt to meet the demand. The Lockheed factory, for instance, built only three planes during 1927, yet was able to build and deliver 50 planes during 1928, and according to present production schedules will turn out at least 200 planes during 1929. Similar production records have been established by a number of other companies to give this country a total production for 1928 of about $27,000,000 worth of commercial aircraft.

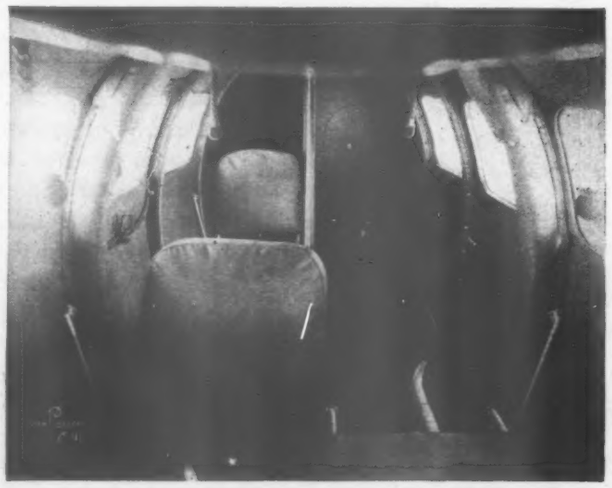
Now with all the established factories stepping up production, and with many new factories preparing to build planes in quantity, the 1928 production figure can be doubled during 1929, provided that there proves to be a market for this number of aircraft. The big problems now worrying aeronautic executives are these: Has aircraft production outstripped the present capacity of the market? Have we already reached a temporary saturation point?

The above questions are rather broad when we consider the many types of aircraft now manufactured, and the fact that some planes now being built may have a very restricted market which is soon exhausted. Also, with the rapid progress in design, new types may destroy the market for many craft now popular. While there is probably a slackening in the demand for some types of aircraft at the present time, we think, here at the Lockheed plant, that the immediate market for certain specialized types of planes has barely been scratched.

From the time that this enthusiasm for flying started in 1927, up to now, planes have been *bought*, not *sold*, and anything which would fly was considered a marketable airplane. With present production schedules, and with the public rapidly becoming educated as to what constitutes a good airplane, I believe that it will be necessary from now on to *sell* airplanes, and what is of greater importance, to *build airplanes to sell*. That is to say, planes must be designed with a certain type of purchaser in mind, and must be built to meet the anticipated requirements of that purchaser in every detail. After all, it is an economic waste to sell a man something, by clever salesmanship, that will not satisfy him. On the other hand, if a product is fundamentally right it is only necessary to acquaint the prospect with its abilities and he will not have anything else.

EVERY manufactured article has a certain definable market and a certain limited number of important sales points. Therefore, every manufacturer must be able to outline his market, must establish a definite attitude toward the potential buyers of his product, and then must build and sell his merchandise so as to hit the bulls-eye of his defined market.

In the past there has been a rather disordered condition in the aeronatuic industry regarding the manufacturer's attitude toward his market. Many manufacturers



A view of the cabin interior of a Lockheed "Executive" looking toward the rear

The Pratt & Whitney "Wasp" powered, Lockheed "Vega" monoplane which made the recent flight from Seattle, Wash., to Juneau, Alaska.

have been content to let people buy planes without making any real effort to build up a sales and service organization for the future. Other manufacturers have sacrificed present sales and production while they have experimented and sought to develop planes for the future market. Here in the Lockheed factory we are sure that we have something of great value to the present market and have bent every effort toward developing an organization that could specialize the construction of our planes to meet every possible requirement of the purchaser. At the same time a country-wide distributor organization of the highest and most permanent character has been built up in order to insure genuine sales service and also continued service on planes in use. Along with this effort to serve the present buyer we have been able to introduce many improvements in design and construction which keep the plane up-to-date without employing untried innovations.

In the aircraft market there are three broad classifications: The light open plane, or sport type; the single engined cabin plane, which has many sub-classifications; and the multi-engined planes, which are essentially the trucks and passenger buses of the air. The Lockheed company builds single engined cabin planes of from five to seven passenger capacity because we believe that this type of plane most nearly meets the requirements of the largest present market, and in point of numbers will eventually be the most popular of all aircraft. We believe that there is an almost unlimited market for our type of plane at the present time among the thousands of business executives and larger commercial organizations of the world, and with the airlines which are now establishing many short feeder routes requiring fast, medium-sized planes, with which to carry traffic to the main lines. In this connection, it is essential that planes for feeder lines should be faster than the large transport planes in order that proper connections may be assured in spite of adverse weather conditions. By placing reliable single engined cabin planes in the service of the leading business men of the country we will win thousands of converts to air transport whose money and enthusiasm will greatly accelerate the development of all kinds of flying.

Another view of the cabin of an "Executive," showing the portable typewriter and stationery file

Regardless of the type of plane built or the demand for it, there are vital reasons why we should merchandise our planes as all other products are merchandised, on a strict business basis. In merchandising of any sort there are usually about five factors which a sales manager must consider:

1. Who are the logical purchasers?
2. Who are the men controlling these purchases?
3. What is the probable quantity which can be sold this year, next year, and the year after?
4. What are the channels through which advertising and publicity should flow?

5. What kind of advertising copy should be developed?

Now it is just as possible to determine these factors for airplanes as it is for electric refrigerators, radios, or automobiles, although it may be a bit more difficult because of the rapidity with which the aircraft industry is developing.

As we have outlined the factors in connection with Lockheed planes they are something like this:

1. The logical purchasers are business executives who place a premium upon time and whose personal attendance at widely separated centers of activity is a real asset; industrial organizations who need the fastest possible transportation of certain men, money, or materials; and airlines needing planes of great speed and medium size, capable of making feeder lines pay a profit.

2. The purchases of planes of Lockheed type are unquestionably controlled by the industrial executives most directly interested in their operation.

3. We know that the quantity sold this year by us cannot exceed our production of 200 planes, but believe that there is an immediate market for several thousand planes of this type among the leading business men of the country. Next year, with business rapidly taking to the air and with airline feeders undergoing great development, we believe that there should be a market in this country alone for at least 25,000 single engined planes of the Lockheed type. After 1930 it is a little difficult to predict with intelligence because of the many factors upon which the rapid development of flying depends, but if adequate night routes have been developed, ample terminal facilities provided, and sensible traffic regulation is developed, we can actually outline a market for at least 50,000 single engined cabin planes yearly.

4. On advertising and publicity we have two widely separate factors to consider in Lockeed airplanes. Because of their speed and beauty they have great popular appeal and the Lockheed company has welcomed the widespread publicity which has been a result of the many new records set with Lockheed planes. On advertising, however, the possible purchasers constitute a certain limited field of business men and Lockheed has restricted paid advertising to the trade magazines which reach airline executives, and to the business, sports, and society magazines which reach the wealthier business men and sportsmen.

5. Advertising copy for Lockheed sales has always sought to emphasize the most important factor in connection with Lockheed's record, *Speed*. Along with speed we seek to play up the colorful beauty of line and finish and the luxurious interior of the plane. Thus we sell the prospect the story that a Lockheed plane will move him from place to place faster than any other means of transportation, will do it with greater comfort than any surface vehicle can offer, and that the plane will be a thing of beauty and a possession of which he can always be proud.

With these five factors determined it is possible to act with decision in the construction and sale of our product. Following the idea that we must build planes to sell, we have always sought first for superior speed, without sacrificing other factors, because speed is the vital thing which all aircraft have for sale beyond anything offered by any other vehicle. Next to speed we consider that specialization of the plane for certain definite requirements is most important, and for this reason Lockheed planes have been adapted to either passenger or express loads; for the use of airline passengers or private executives demanding the last word in luxury, convenience, and speed; and for operation from land, water, snow, or ice.

Taking all main sales points into consideration we rank them in what we feel to be their order of importance to a sale, something like this: (1) Speed, (2) specialization to purchaser needs, (3) beauty, (4) comfort, (5) utility, (6) serviceability, and (7) safety.

Taking these points in order, we believe that speed is the most important because the aircraft market is so highly competitive. Planes are competing against surface transportation on the basis of speed, airlines are competing against each other on the basis of time saved over a given route, and planes are being sold largely on their ability to get pay loads delivered faster than competing planes. Surely the popularity which Lockheed planes have enjoyed from the beginning is because, without sacrificing other factors, they provide superior speed.

We think that specialization of the plane to purchaser needs is the next biggest factor in the market, and is, in many ways, of more importance than speed. In order to provide a plane for every type of service within the market served by Lockheed we have developed three different craft. First, the standard "Vega" model for straight passenger carrying or the use of charter parties and feeder lines where no mail or express is carried; then the "Air Express," for mail lines and feeder lines carrying variable loads of freight and passengers; and finally, the "Executive," which is built for the private transportation of business men who need the utmost speed and at the same time wish de luxe comfort and the opportunity to work while en route, if necessary.

EACH OF THESE three models has been adapted by Lockheed engineers for operation from land, water, ice, or snow, thus providing for the use of Lockheed planes under almost any conceivable condition of weather or geography which permits of flight at all.

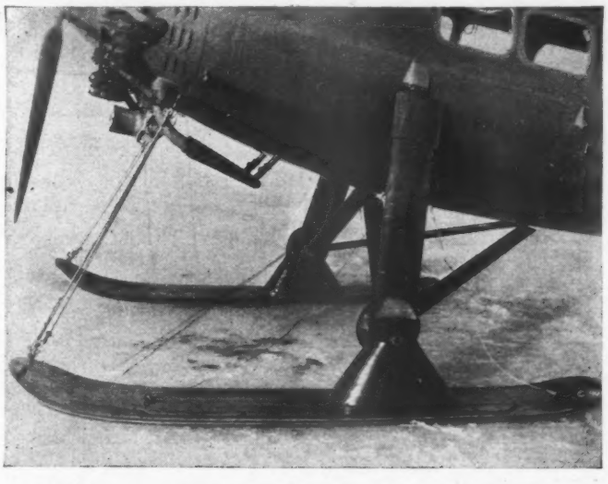
The varied uses to which Lockheeds are now being put indicates to the industry the desirability of this sort of specialization. Maddux Air Lines, Universal Air Lines, Santa Maria Air Lines, Northern Air Lines, Commercial Airways, Ltd., Southwest Fast Air Express, Nevada Air Lines, Washington-Alaska Airways, Texas Air Transport, and United States Air Transport have all placed Lockheed planes in passenger or mail transport service, indicating the importance of building planes suited to the needs of such airlines. Commercial Airways, Ltd., operating between Edmonton and Fort Reliance, Canada, has been supplied with planes equipped with wheels, floats, and skis, and these planes are operated from snow, ice, water, or land, according to the varying conditions met. The Washington-Alaska Airways have commenced operations between Seattle and Juneau, and have ordered six "Wasp" Vegas equipped with pontoons, to fly a 1,000 mi. route over the inland waters of British Columbia and southern Alaska. Although a Lockheed plane on pontoons recently made this

flight non-stop in seven and a half hours, the scheduled time for the trip, with stops, will be 10 hr.

As an indication of the extent to which specialization of aircraft may be carried, the Lockheed Executive is equipped with a typewriter, writing desk, stationery file, phone to pilot's compartment, full length couch, and lavatory. That such a plane will find instant favor with business men is indicated in purchases made by the B. F. Goodrich Co., Marland Oil Co., and William Gibbs MacAdoo.

Beauty is rapidly becoming a dominant factor in aircraft selling, as evidenced by the recent trend toward brighter and more harmonious colors, and cleaner exteriors. Fortunately for us the lines of the Lockheed plane are inherently beautiful and this appearance is enhanced by finishing the various planes in any color combination desired by the purchaser. As one leading paint manufacturer is so aptly advertising, there is no reason why airplanes should be painted to resemble mud turtles when the birds of the air are the most colorful of all creatures.

COMFORT has not heretofore been given the attention it deserves. An airplane is a vehicle of luxury, inherently smooth in flight, and we believe that the utmost luxury should be provided in interior appointments, so that the purchaser will feel he is buying the finest vehicle, land, water, or air, that can be obtained. In all Lockheeds,



A Lockheed monoplane equipped with skis for winter operation. Three planes, fitted in this manner, are employed by Commercial Airways, Ltd., in Canada during the winter months

for instance, the entire interior is richly padded, carpeted, and upholstered, seats fold for utility and comfort in moving about, hand grip cords are provided for each passenger, sliding windows, controlled ventilation, heaters, all are built in.

Utility and serviceability of anything, bricks or airplanes, are factors of the utmost importance, but since aircraft are considerably more expensive than bricks, utility and serviceability as sales factors usually rank far below such items as performance and appearance. However, airlines do not buy planes which will not pay profits and genuine utility must be built into the plane that would serve airline needs. Utility of aircraft is a bit difficult to define at this state of development but it is probably something of a combination of performance with given load, ability to get the load in and out of the plane quickly and easily, and manner of disposing the load within the cabin or compartments. Wide doors, unobstructed interiors, and ability to handle various types of loads are factors of considerable importance, and must be so regarded.

SERVICEABILITY involves two factors: service during normal operation, and servicing after a crash. One of the biggest sales points in favor of Lockheed planes is that during normal usage they require no servicing beyond periodic inspection and painting. This is an important feature of modern aircraft and for quantity sales we must be able to offer planes that will not get out of alignment and which have no hidden parts to rust or deteriorate. Servicing a plane after a crash is a matter which should always rest with the policy of the factory building the plane. The Lockheed factory has developed a highly satisfactory technique for repairing all minor damages to wing or fuselage. However, although utility and serviceability are of the most fundamental importance, they are not primary sales points, but rather represent the hidden value which must be built into any product seeking lasting good will.

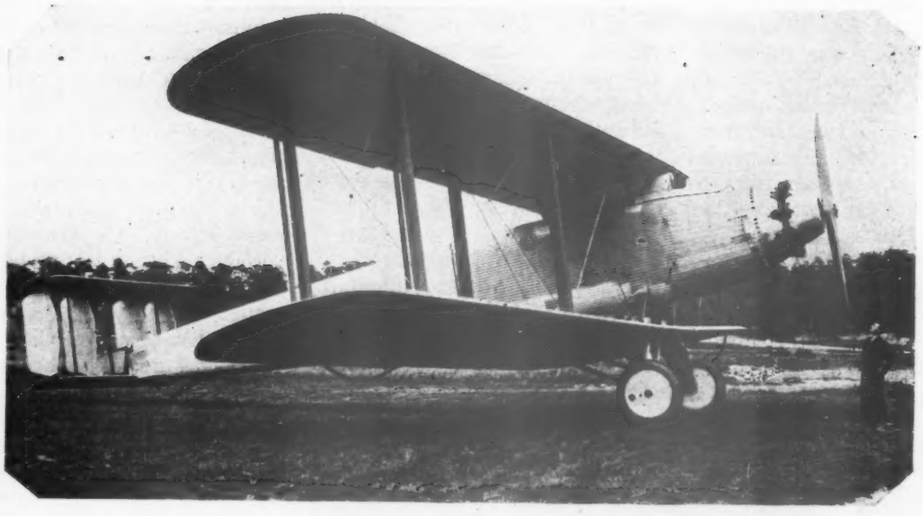
Safety is listed as the least important sales point because we believe that it is no longer a logical sales point in connection with selling airplanes. All standard makes of planes are now conceded to be of approximately equal safety and it is difficult to build much of a selling argument on the supposition that one plane is safer than another. The better line of attack is to point out that with a good pilot, fair weather, and average terrain, any standard plane can be landed in emergency without a serious crash. Although not the most important sales point, safety is the most important consideration in manufacture and design of planes and cannot be neglected. Such matters as providing emergency exits, padding sharp obstructions or eliminating them, installing safety belts, etc., are things that cannot be neglected by the manufacturer.

There are, of course, innumerable points of difference as between various planes of the same general type, and perhaps many sales can be made on the basis of such minor talking points, or selling features, but we believe the most important of all sales points is superior speed, without sacrifice of other factors, and that the most important line of action for the manufacturer of aircraft is to build his plane for special services to fit the needs of the many different classes of purchasers within his particular market.

We must not lose sight of the fact that all forms of surface transportation have admittedly approached their maximum practical speeds, and minimum costs of operation, leaving the airplane alone to offer the possibility of great increases in speed of travel along with hope for considerable reductions in operating costs. The plane was not developed primarily for sport or pleasure, but from the very beginning has had increased speed over other forms of transportation as its excuse for being. Especially in America speed is the demand of our entire trend in transportation, for time spent travelling is considered time wasted. We cannot hope to predict the speeds to be attained in the future, but of one thing we can be sure: the speeds of the future will be tremendously in excess of those now employed, they will be accomplished through the air, and the planes which deliver the most speed, without sacrificing the other factors, will be the planes which will be most widely sold.

THE VICKERS *"Vellore"* FREIGHT CARRIER

INTENDED primarily for service as a freight carrier, the "Vellore," recently developed by Vickers, Ltd., Westminster, London, S. W., has proven very successful in the service for which it is intended. Allowing for the weight of pilot and fuel for 350 mi. this plane has a payload of 7½ to 8 lb. per hp. A number of unusual features are incorporated in its design.



The Vickers "Vellore" folding wing biplane, designed primarily as a freight carrier

The Vellore is a two-bay, folding wing biplane built entirely of metal excepting the wings, tail units and rear portion of the fuselage, which are covered with fabric. The power plant is either the Bristol Jupiter IX, which develops 525 hp. or the Armstrong Siddeley "Jaguar" (geared) engine which develops 460 hp.

With the Armstrong Siddeley engine the weight of the plane empty is 4,734 lb., the payload 3,625 lb. and the gross weight 9,500 lb. With the Bristol Jupiter the weight empty is 4,759 lb., the payload 3,600 and the gross weight loaded 9,500 lb. The plane has a length of 51 ft. 6 in., a wing span of 76 ft. and a height of 16 ft. 3 in. The width with wings folded is 20 ft. 9 in.

The maximum speed of the Armstrong Siddeley powered plane is 110 m.p.h., the initial rate of climb 410 ft. per min. and the absolute ceiling 13,850 ft. The landing speed is 48 m.p.h. With the Bristol Jupiter engine the maximum speed is 114 m.p.h. and the landing speed is also 48 m.p.h. The initial rate of climb is 515 ft. per min. and the absolute ceiling 17,100 ft. In both cases the cruising range is 350 mi.

In this design a low maximum speed was deliberately selected to provide a high pay load capacity for operation over difficult country where the airplane would be superior to any other form of transportation.

The duralumin used in the wing and fuselage is protected against corrosion by the anodic oxidation process, after which it is sprayed with a cellulose paint. The wings are of constant chord and equal span and the fuselage is attached to the wing cellule by struts at the top and bottom. A biplane tail having two balanced elevators and four balanced rudders provides easy and effective control. The ailerons also are balanced.

The cabin is 12 ft. 9 in. long, 4 ft. 9 in. high and 3 ft. 9 in. wide, giving a capacity of 225 cu.ft. A hinged door between the cabin and the rear portion of the fuselage is provided with blocks and tackle for handling freight. The dimensions of this opening assure the easy loading of lengths of pipe line, machine tools or other bulky articles.

The specifications as furnished by the manufacturer:

Length	51 ft. 6 in.
Span	76 ft.
Height	13 ft. 3 in.
Width (wings folded)	20 ft. 9 in.

Performance and weight, (Armstrong-Siddeley)

Weight empty	4,734 lb.
Payload	3,625 lb.
Total weight	9,500 lb.
High speed	110 m.p.h.
Landing speed	48 m.p.h.
Initial rate of climb	410 ft. per min.
Absolute ceiling	13,800 ft.
Climb to 4,920 ft.	15 min.
Power loading	20.6 lb. per hp.

Performance and weight, (Bristol Jupiter)

Weight empty	4,759 lb.
Payload	3,600 lb.
Total weight	9,500 lb.
High speed	114 m.p.h.
Landing speed	48 m.p.h.
Absolute ceiling	17,100 ft.
Initial rate of climb	515 ft. per min.
Climb to 4,920 ft.	11½ min.
Power loading	19.6 lb. per hp.

Heating AND *Ventilating* FOR *AIRPORT BUILDINGS*

Article III

Design of Boiler Plant, Smoke Stacks and Selection of Fuel

By E. C. BLACKBURN, Jr., M.E.

LIKE ALL the other equipment for a heating system there are many makes of boilers, pumps, etc., on the market. Some of these are more suitable for certain service than others and most of them have their uses and will prove satisfactory if they are properly installed.

As is true of most things that are offered to the public, there are many different grades or qualities available. If the owner happens to be a person who wants the best that can be had, and is willing to spend enough on this phase of the airport, high-class equipment is available. And if he wants the cheapest thing he can get, this equipment is also available.

While it is not essential to use the most expensive equipment to be had, the material which is to be installed must not be of inferior quality or it will be a constant source of worry and expense.

The higher priced pieces of equipment in most cases will have a much longer life than the cheaper ones, due to the fact that they are more carefully designed, the workmanship on them is better, and materials used in them is of a higher grade.

For the average airport it will be well to strike a happy medium and use equipment that is reasonable in price but still has a background of successful use in many other installations. In other words, it must be an article that is known to be reliable, yet one which may be purchased for a reasonable price.

In designing our boiler plant the first thing we will do is to select the boilers themselves. The types of low-pressure heating boilers available may be divided roughly into two classes, cast-iron, and steel. Both of these types will give satisfaction if they are properly installed, provided that they are large enough to handle the load. Some manufacturers have a tendency to over rate their boilers. This is bad practice and is often the cause of much trouble.

The cast-iron boilers are made up of a number of individual sections fastened together similar to the way direct radiator sections are fastened together. These sections are cast in such form that when the sections are put together the firebox is formed by a certain number of sections near the front of the boiler. The entire boiler is then covered with insulating material. Steam connections are taken off the top of two or more sections.

The steel boilers commonly used for this service are of the portable firebox type. They may be either welded, or riveted. Several of these boilers that are very similar in construction are available. One boiler of this type is illustrated in Fig. 2, in which the path taken by the hot gasses is clearly illustrated.

The number and size of the boilers required for a certain installation depends of course upon the total heating load. It is not practical to install one extremely large boiler even though it may be ample in size, for the reason that in very mild weather this boiler would be operating at a small fraction of its rated capacity with a consequent reduction in efficiency. The plant should be composed of two or more boilers of a reasonable size. When this is done, in mild weather, instead of operating a very large boiler

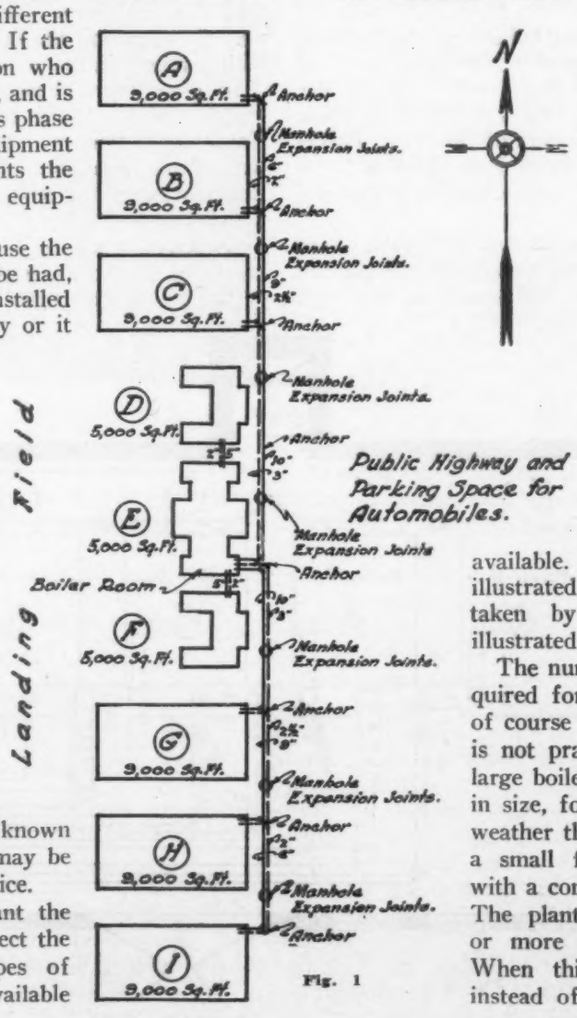


Fig. 1

at a low efficiency, it becomes possible to operate one or more moderate size boilers at maximum efficiency.

Therefore, in our boiler plant, we will select two or more boilers. If we use two boilers they must have a total capacity of 80,000 sq.ft. of direct radiation or 40,000 sq. ft. each. These would be too large, so we

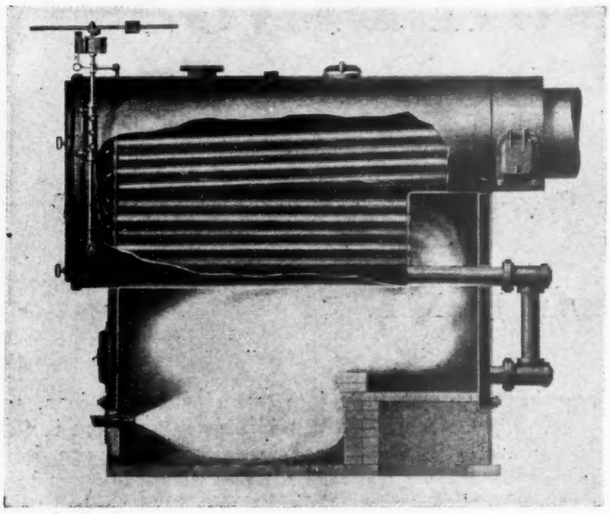


Fig. 2

will try three boilers. If three boilers are to be used they must each have a capacity of 80,000 sq.ft. ÷ 3 = 26,666 sq.ft. This is getting down within reason but we will assume that the ceiling height in the boiler room makes it impossible to install boilers of this size. Therefore, we are forced to occupy more floor space and less height, so we will select four boilers, having a capacity of 20,000 sq.ft. each.

These boilers are located as shown in Fig. 3. The smoke connection *n*, Fig. 3, from each boiler is connected to the breeching, *o*, Fig. 3. The smoke is conveyed through the breeching to the smoke stack as shown.

While on the subject of smoke let us consider the smoke stack a moment. Smoke stacks and other high objects located on an airport are a constant source of annoyance and danger. Each fuel burned in a boiler requires a certain amount of air for combustion. If this amount of air is not supplied, combustion is not complete and the maximum efficiency is not obtained from the fuel when used in this way.

Smoke stacks are not used merely to carry the smoke from the boilers up to a height where it will not blow in our faces, as some people not familiar with the subject seem to think. High stacks are used primarily to obtain enough draft to provide sufficient air for complete combustion.

The draft in a smoke stack is created by the height of the stack and the difference in temperature between the air in the stack and the air outside the stack. The hot air in the stack is lighter, due to its higher temperature, than the air outside the stack. Its natural tendency then is to rise, or to be pushed up by the heavier air entering the base of the stack via the ashpit of the boiler.

THERE IS only one way to avoid these high smoke stacks and that is to provide a system of forced, or induced draft. If this is done the movement of air through the boiler and smoke stack is accomplished by the use of motor-driven centrifugal fans, similar to those used for ventilating purposes.

In this case the smoke stack can be kept down to a very few feet higher than the surrounding buildings. It would seem that this would be a very important matter and one worthy of serious consideration in an airport installation.

In installing the boilers it is advisable to locate them in such a manner that there will be ample room for access to the sides. There must be sufficient space in the rear to permit the breeching to be properly installed, with dampers in the smoke connection to each boiler.

In front there should be a clear space a foot or so longer than the length of the longest tubes in the boiler. This is to permit the cleaning of tubes to be carried out with a minimum amount of labor, and also to allow sufficient space for replacing tubes in case this should be necessary.

Directly on top of each boiler we will install a stop valve on the steam connection, *a* Fig. 3. From these valves the steam is piped, *b*, to the steam header *c*.

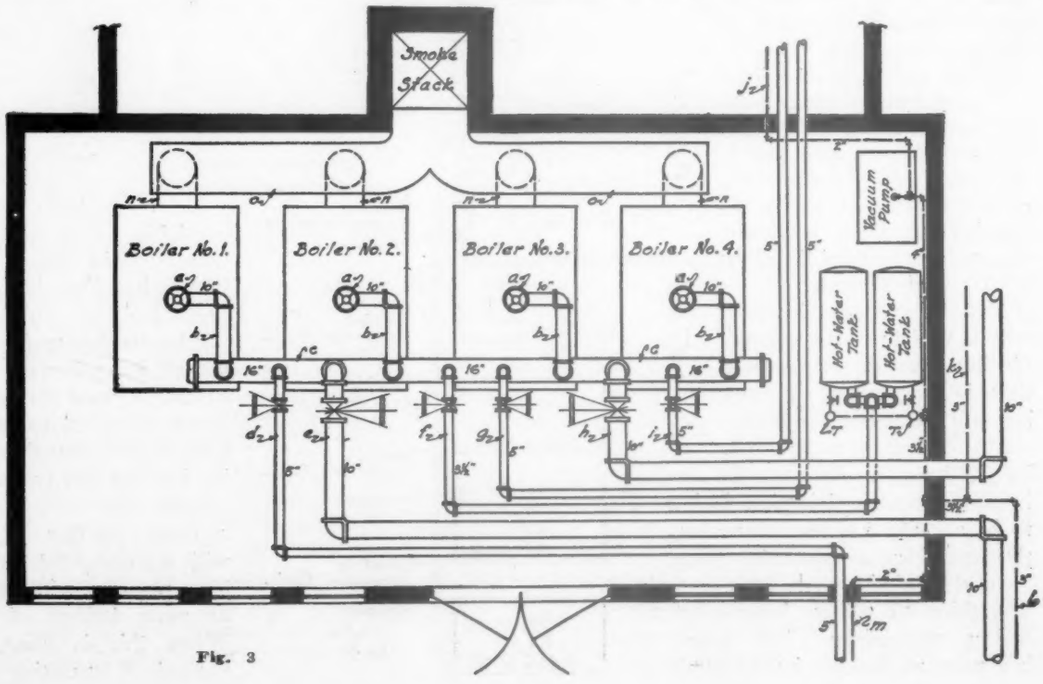


Fig. 3

From the steam header *c*, separate connections are taken off as follows:

d Fig. 3—Steam to building *F*, Fig. 1
e Fig. 3—Steam to hangars *G*, *H*, & *I*, Fig. 1.
f Fig. 3—Steam to the hot water heaters.
g Fig. 3—Steam to building *E*, Fig. 1. (The boiler plant building.)
h Fig. 3—Steam to hangars *A*, *B*, & *C*, Fig. 1.
i Fig. 3—Steam to building *D*, Fig. 1.

This steam piping if sized according to the same table we used in sizing the piping in hangar *A*, Fig. 1, will be as shown in Fig. 3. Valves are installed in each of these lines close to the steam header.

By this arrangement it is possible to control the steam supply to either the North or South group of hangars or any one of the other three buildings.

For example, in mild weather it may not be necessary to supply steam to the hangars and yet it will be a little too cold not to supply steam to the three central buildings. In this case the valves in *e* and *h* will be closed, shutting off nearly all of the underground piping.

Under these conditions it will be possible also to shut down one or more boilers. Incidentally, a log should be

Fig. 4

kept of the operation of the boilers so that an accurate record will be available of the length of time each boiler has been in operation. This should be, as nearly as possible, the same for each boiler.

A boiler room similar to the one we are designing here is shown in Fig. 4.

The return mains from the various buildings are shown in Fig. 2 and are as follows:

j Fig. 3—Return from buildings *D*, & *E*, Fig. 1.
k Fig. 3—Return from hangars *A*, *B*, & *C*, Fig. 1.
l Fig. 3—Return from hangars *G*, *H*, & *I*, Fig. 1.
m Fig. 3—Return from building *F*, Fig. 1.

These returns from the various buildings are all connected together as shown in Fig. 3. The main return is connected to the vacuum pump as shown.

The vacuum pump is a device, as its name implies, that draws air from the return mains keeping them under a reduced pressure. This has the advantage of causing the steam to circulate more rapidly, makes possible the use of smaller return piping, and also makes it possible to operate the system on lower steam pressures. One of many types of modern vacuum pumps for use in connection with heating systems is shown in Fig. 5.

The vacuum pump expels the air drawn from the piping system to the atmosphere and also performs the duty of a boiler feed pump. That is, it pumps the condensed steam, or water, back into the boilers, where it is again evaporated into steam.

The hot water tanks shown in Fig. 3 are regular tanks built for this purpose. They consist of a regular hot-water storage tank in the lower part of which is installed a steam coil for heating the water.

The temperature of the water in the tanks is automatically controlled by a thermostatic device immersed in the water which actuates a valve in the steam supply piping to the steam coil. Thus when the water in the tank reaches a predetermined temperature, the valve in the steam pipe is automatically closed. When hot water is drawn from some of the hot-water faucets and the temperature of the remaining water in the tank is lowered, the steam valve is automatically opened again.

A TRAP, *T* Fig. 3, is installed on the return end of each heating coil, performing the same function as those we installed on the unit heaters in the hangars. The return from the hot water heaters is connected into the returns from the buildings and goes to the vacuum pump also.

The continuation of the underground piping to the various buildings is shown in Fig. 1. By running the steam supply and return piping, *i* Fig. 3, to building *D* Fig. 1 through the basement of building *E* Fig. 1 we saved quite a long run of underground work.

Just outside the boiler room and at intervals as shown in Fig. 1 we must anchor the steam and return piping. This is usually accomplished by securing a special fitting to the pipe and burying the base of this fitting in a concrete block.

The piping must expand and contract as it heats and cools, therefore, between each two anchors we will install expansion joints in the piping. We will also provide manholes for access to these expansion joints.

The underground piping should be installed in a well-drained concrete trench in a manner similar to that shown in Fig. 6. The pipes are supported on rollers of some form so that they are free to expand and contract between the points where they are anchored.

The piping should be covered with a good grade of insulating material to reduce as much as possible the loss of heat. This insulation should be protected by a waterproof coating of some good material. Wrapping the insulation with heavy roofing paper, securely fastening it in place with wire, and painting this with one or more coats of hot asphalt paint has been found satisfactory.

Provision should be made to keep the trench in which these mains are installed dry. Water around this piping will first destroy the insulation, then absorb heat from the steam in surprisingly large amounts. This will be immediately reflected in the cost of operation of the plant. I have known of cases too, where relatively cold water suddenly came in contact with hot steam mains causing the fittings to fail. Replacing these fittings in an underground line is quite an expensive process too.

Quite often there are a number of buildings on an airport that are occupied by firms other than the owners of the airport. In this case some provision should be made in the steam distribution system for charging the occupants of these buildings for the steam consumed. This can be accomplished in several different ways.

The method that is most fair to all parties concerned is to meter the steam used in each building. By this method occupants of the various buildings pay for heat in much the same manner that they pay for electricity, gas, etc.

Steam flow meters may be installed in the steam service piping to each individual building, or condensation meters may be installed on the return from each building. In either case the meters may be located in the buildings or they may all be located in the boiler room. It is more desirable to have them located in the boiler room, but this complicates the underground piping system to quite an extent with a consequent increase in cost. This is due to the fact that if the meters are located in the boiler room it becomes necessary to run either an individual steam or return main to each building.

The rate charged for the steam supplied must be based upon the cost of generating the steam. This must include the cost of fuel, labor, maintenance, interest, depreciation, etc.

THERE MAY BE instances where individual heating plants in each building may be more advantageous. Usually though, the central heating plant as we have outlined in these articles will be the best. If individual systems are installed in each building they will in most cases be operated by a person who knows nothing about them and cares less. For this reason they will be short-lived and will require a large number of expensive repairs. With the central heating plant all of the principal equipment is located in one place where a competent man can supervise the operation of it and give it the attention it deserves.

The only other means of charging for heat in those buildings leased to individual firms is to estimate the amount of heat they will use and include the cost of it in the rental charged. In this case there is no incentive for the occupant of the building to economize because he reasons that he has to pay for it whether he uses it or not.

In this case the airport owner must take this into consideration when determining the amount to be included in the rental fee, to protect his own interests. The whole proposition then becomes unfair to the occupant of a building who is concientiously economical in the use of steam. He is being forced to pay for the steam that the other fellow wastes.

Reasonably accurate condensation meters may be installed that are quite inexpensive. They may be installed in a small out-of-the-way space in each building. Steam flow meters are more accurate but are also more expensive and require more attention.

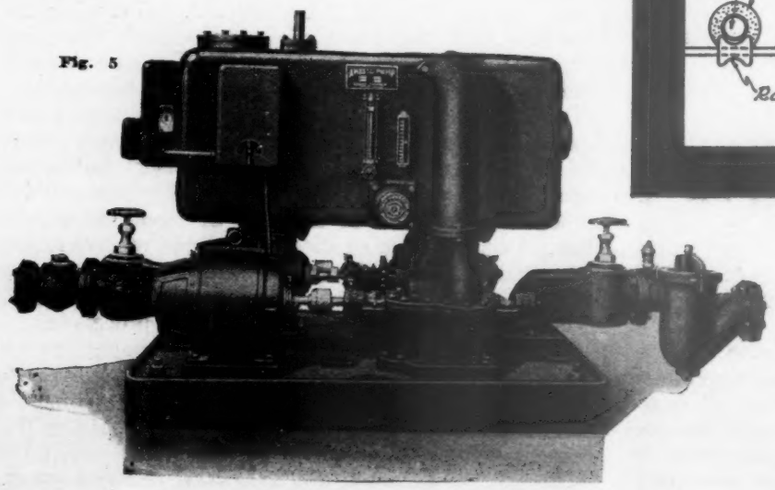


Fig. 5

THE MATTER of fuel is one of great importance and should be given careful consideration. Offhand, I would say that in nearly all cases it will be most desirable to use oil fuel. This will eliminate a large amount of labor and will make installation requiring a minimum of attention.

Then too, when oil is used for fuel a profitable method of disposing of used lubricating oil from the airplane engines is provided. This oil may be strained and poured into the fuel oil tanks. The accumulation of used oil during the summer season when the plant is not in operation will in many cases be sufficient to reduce the fuel bill considerably. In some cases it may be available in sufficient amounts to provide fuel for the entire heating season.

In localities where natural gas is available at a very low price it may be advisable to use gas for fuel and find some other method of disposing of the used oil.

The use of solid fuels such as coal, wood, etc., should be avoided wherever it is possible to do so. The space occupied by a supply of these fuels is quite large, they are difficult to handle, and make necessary the handling and disposal of ashes.

It is to be hoped that some day it will become general practice to locate airports on high well-drained ground. The present tendency seems to be for any city that has swamp conveniently located to fill it in and make it an airport. This makes it necessary to install elaborate drainage systems and causes a great deal of anguish on the part of the engineers who are called upon to design the various phases of the work.

It makes it extremely difficult to obtain adequate bearing surface for the foundations for the boilers and other heavy pieces of apparatus. It makes the installation of the underground mains very difficult, and in many cases makes it necessary to locate the boiler room entirely above ground, in which case it usually becomes necessary to build a separate boiler house. However, a separate boiler house in some cases is more desirable. In conclusion it is the hope of the writer that enough has been said on the subject to awaken the present and future builders of airports to the importance of this portion of the work, and to the necessity of having it done by an engineer who is well qualified to do heating and ventilating work and has had experience in this work in the aeronautic field.

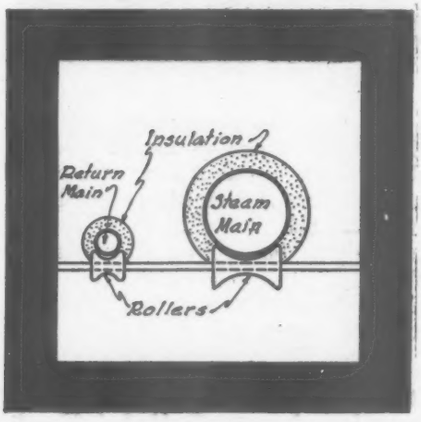


Fig. 6

Lumber Built AIRPLANE HANGARS

By N. S. PERKINS, C. E.
Staff Engineer,
National Lumber Manufacturers' Association

An Advocate of Wooden Hangar Construction Presents His Opinions on Their Economic Advantages

UNTIL there is more certainty along what lines aviation will ultimately develop both in plane design and as a public service, there is going to be some uncertainty as to the proper lines along which airport facilities, in the more detailed arrangement, should be planned.

Meanwhile, as a matter of good business practice, it is well to look upon the airport, whether it be municipally or privately owned, as a commercial "plant" and to arrange its important details along business lines with a view to present economy and with an allowance for probable changed future requirements. As a business matter, there are those who consider hangar investment at this time the key to economical port, or, let us call it plant, operation. It is here that money can be spent foolishly; or rather it is here that a heavy investment in overhead can be sunk by the executive who figures there will be no change in fashion or requirements and who encourages the erection of costly, unwieldy structures.

An interior view of the Standard hangar at Clover Field, Santa Monica, Calif. The roof is of wooden construction, built up of small units bolted together

Landing fields, lighting arrangements and such equipment are somewhat rigidly determined by present physical requirements. We practically have to build them as at present designed for present day operations, even though we know a change may be coming. It is different with the buildings on a port. In these there is room for selection and a choice can be made as to the materials to be used. In making this selection the executive should keep a business eye to the probability of changed future requirements. He can defend this attitude on a basis of practical economy, and there is no reason why, in an effort to flatter the community or create a showplace, he should indulge in heedless expenditure of either civic or stockholders' dollars.

The first question a business-like consideration of hangar construction raises is: How far will the investment go—what will we get for this particular overhead? This ivolves total first cost, the service the hangar will give in plane housing and plane repairing accommodations, year by year upkeep charges, the heat it will keep in and the cost of this heat in cold climates, as well as the heat it will keep out so that mechanics can work in warmer climates, fire resistance, durability, adaptability to economical expansion and remodeling, and finally, salvage value in the event the development of the in-

dustry or public whim compels ultimate total demolition of the particular type of hangar to be built.

Frequently the difference in cost between a reasonable type of construction, which will adequately answer present purposes, and a very expensive hangar of a more permanent type, is so great that the annual savings from the lower interest charges will offset either the upkeep economies or the permanence of the more costly structure. Take, for example, a 100x100 ft. hangar which can be built for, say, $12,000 if of wood and for $40,000 if of concrete and steel. It should be explained that these figures will be found to be more practical than arbitrary.

With them, the problem sets itself up in this way:

For the Wood Hangar:

Interest on $12,000 at 6 per cent	$720
Maintenance (2 per cent annually) (Based on 1.73 per cent for framed buildings as average assessment figures used by all authorities.)	240
Amortization (based on 20-yr. life with money at 4 per cent)	403
Total annual charges	$1,363

For the Concrete-Steel Hangar:

Interest on $40,000 @ 6 per cent	$2,400
Maintenance @ 6 per cent	400
Amortization (based on 50-yr. life and omitting obsolescence factor.)	262
	$3,062

Even if we assume a 15-yr. life for the wood hangar, which is evidently much too low, and assume, also, a four per cent maintenance charge, which is too high, the annual charges on the lumber hangar are only:

Interest	$720
Maintenance	480
Amortization	598

These figures give a total of $1,798 which is still 40 per cent less than the expense each year of the concrete-steel type. It should be remembered also that the lumber building lends itself very readily to the inevitable remodeling or expansion, thereby still further reducing year to year costs.

Before jumping to the conclusion that because of these economies the wood hangar is the most desirable, let us consider some other important factors.

What about heating? Most types of hangars can be heated fairly well, the exception being the sheet metal siding construction, which, however, is little used in Northern climates. About the best insulating type is the wood hangar with inside sheathing and with a good quality of building paper between the outside sheathing and siding. Such side walls are very effective heat insulators, greatly excelling the average concrete or brick wall in this respect, according to authoritative engineering data. Heating plant operation and other factors will determine how much of a saving in the winter coal bill this will make. In the summer this same insulating value keeps the heat out, and in warmer climates has an important bearing on the actual production of mechanics forced to work indoors.

What about fire safety? The prospective hangar builder is often worried about this. Wood is combustible, but the significance of this, especially in comparison with other materials, is often misunderstood. Experience shows that it is usually the contents of the building that make the fire, and fires in all types of hangars have demonstrated that no type of construction is free from damage hazard caused by such contents fires. At an airport conference recently held under the auspices of the Department of Commerce it was stated by an authority on fire prevention that "experience with over 30,000 fires has sufficiently indicated that the character of construction is of very little consequence in fire control."

Airport managers, no matter what the type of construction, should see that the hangar is kept free from débris, and that precautions are taken against explosions

A wooden hangar, such as this one used by Pitcairn Aviation of South Carolina, Inc., is said to have many advantages

resulting from sparks. Hand extinguishers and foamite tanks should be kept at hand for immediate use. The anti-fire sprinkler system is being recommended by the National Board of Fire Underwriters and they are proposing attractively low rates for nearly all types of hangars that have it installed. Some port builders have questioned its need based on experience, but tests are to be conducted to demonstrate the sprinkler system effectiveness. Meanwhile, with the underwriters offering low rates on sprinkler equipped wood hangars and with experience to demonstrate that contents and care of the premises are more important fire elements than structure type, the executive who builds a wood hangar can count on both low insurance rates and investment protection on a basis he can defend before stockholders.

It should also be remembered, wood framing has a record for reducing the losses incident to fire, such as wrecked planes, personal injuries and the like. When the framing timbers have charred they serve as a fire retardant, almost invariably remaining in place, whereas other materials are wont to buckle or crumble under the intense heat, especially when cold water is suddenly thrown on to the heated members.

Another factor that should be considered along with the fire hazard is the storm hazard. This has already proved its capacity for doing damage in the airplane

The interior of a wooden structure, showing the neat appearance of this type of construction

hangar field in the recent demolition of a Buffalo hangar. That storms have not wrought wider havoc at airports is undoubtedly due to substantial construction plus the fact that storms have not happened to strike some ports where construction is not sound. Experience with buildings similar in design gives ample evidence of what would happen in a hard wind storm to hangars so constructed. The Buffalo experience was an instance based more on character of construction than on the material used. Presumably in an effort to economize, the Buffalo hangar was built with an eight inch brick wall, a thickness approved by the suggested building code of the Department of Commerce, but only with the understanding that it is to be specially reinforced or strengthened. During a heavy windstorm the air blew through the windows and was compressed against the interior walls and roof. The wood truss roof had been substantially built, but the wall gave way. One wall was practically demolished and a large hole was torn in another wall.

An airplane hangar constructed of both wood and sheet metal

What about durability? The question of durability resolves itself more into a matter of obsolescence. Hangars of all types can be built to stand up for 20, 30, or 40 years. But the problem is rather how long will you want the hangar to stand. It is inconceivable that a hangar built to meet present ideals will be an ideal hangar even five years hence. When will the hangar of today become obsolete? When will you want to remodel or remove your hangars?

The same factors that apply to the selection of the side walls of a hangar apply to the selection of the roof. In addition, in constructing the roof, requirements make it necessary to eliminate inside bearing posts or pillars. This is easily accomplished with the wood roof. Also, the Lamella and other principles of trussless wood roof construction are now available, so that either truss spans or roofs from which the truss idea has been eliminated can be built. In either choice, spreads of 120 ft. or greater can be readily spanned without the installation of obstructing pillars. Arched wood roofs without truss obstructions are going to provide adequate housing heights for planes of long perpendicular measurement,—at least for the plane developments that can be projected at this time.

The practicality of these various considerations favoring the lumber built hangar is demonstrated in the present trend toward wood construction. At present nearly two-thirds of all hangars in this country are either roofed with or entirely built of lumber. A booklet on Airplane Hangar Construction published by the National Lumber Manufacturers' Association, for the prospective hangar builder to have handy, listed, as of last December, 79 prominently located hangars built of lumber. There have since been several well known additions. This widespread choice is not based on any particular fetish. It is a demonstration of the practical mindedness of those charged with the expenditure of investments that go into airport building. Original cost economy, potential remodeling economy, upkeep economy and satisfactory performance have undoubtedly dictated their decisions.

GENERAL NEWS

Refueling Endurance Mark Raised to 246 Hr. 44 Min.

Whirlwind Powered Buhl Sesquiplane Used

CULVER CITY (CALIF.)—Roy L. Mitchell and Byron K. Newcomb, who recently established a world's refueling endurance record of 174 hr. and 59 sec. at Cleveland, Ohio, held that record for less than four days. It was broken the evening of July 9, when L. W. Mendell and R. S. Reinhart had kept their Buhl cabin sesquiplane in the air here for an hour more than the record time, and it was completely shattered when they stayed up a total of 246 hr. and 44 min. before landing.

Both the plane and the engine used in establishing the new high refueling mark were old. The engine, a Wright 220 hp. "Whirlwind," is reported to have been flown approximately 450 hr. before the endurance flight was started, while the plane had travelled some 16,000 mi. The engine, of course, was overhauled before the record flight was attempted. However, it was not the failure of the engine, the plane, or the fatigue of the crew that caused the "Angeleno," as the Buhl was named, to land. The plane was finally forced to the ground when the tail surfaces were damaged in an attempt to perform another refueling operation early in the afternoon of July 12, it is said.

Used 2,200 Gal. of Fuel

The "Angeleno" took off from the Culver City Airport July 2 at 7:29 a.m. Pacific Coast time and remained in the air until 2:13 p.m., July 12, a total of 10 days, 6 hr. and 44 min. In that time, the Whirlwind engine utilized approximately 2,200 gal. of fuel, which were fed into the tanks of the plane in 100 gal. amounts from a Curtiss "Carrier Pigeon," that was used as the refueling plane. At the outset, foggy and rough weather was encountered, which made refueling extremely difficult. In fact, at one time it is believed the planes would have crashed had it not been for their skillful handling. Toward the end, there was more rough weather, but in that instance the refueling contacts were made over the ocean. For the most part, though the weather was good.

For having set the new world's refueling endurance record, Buhl Aircraft Company, Marysville, Mich., and Wright Aeronautical Corporation, Paterson, N. J., have presented Pilots Mendell and Reinhart with a new six-place Buhl plane, equipped with a 300-hp. Wright "Whirlwind-Nine" engine. Herbert Hughes, general manager of the Buhl plant, Lieut. "Jimmie" Johnson, chief test pilot, and C. H. Hecker, a member of the board of directors, left Marysville, Mich., for California in the new plane several days before the record shattering endurance flight ended.

Editor's Note—Details concerning the equipment and accessories used on the endurance plane will be contained in the next issue of AVIATION.

Approve NB-3 And Ford 6-AT

WASHINGTON (D. C.)—Two new Approved Type Certificates were issued by the Aeronautics Branch during the week ending July 13, 1929. They are as follows: No. 173—Ford-Stout Model 6-AT, 15 place monoplane, three Wright J-6 300 hp., gross weight 11,738. No. 174—Nicholas-Beazley Model NB-3, three place open monoplane, LeBlond "60" Model 5-D, gross weight 1,373.

Additional Cleveland Exhibitors

CLEVELAND (OHIO)—Additions to the exhibitors' list, National Air Races, are given as follows: S.K.F. Industries, New York; Russell Parachute Company, San Diego; Alexander Aircraft Company, Colorado Springs; Henri DeLotty Aircraftsmen Company, San Francisco; Packard Electric Company, Warren, Ohio; Comet Engine Company, New York City; Standard Oil Company of Illinois, Chicago; Davis Aircraft Corporation, Richmond, Ind.

Miami Accepts Curtiss Offer

MIAMI (FLA.)—Forty acres of land at Opa-Locka probably will be used by Goodyear-Zeppelin Corporation as a site for the training school and the base of operations for a sight-seeing service to be established here, it is reported. The city commissioners have accepted the offer of Glenn H. Curtiss Properties, Inc., of the land.

Approve Accessory Section of A.C. of C.

NEW YORK (N. Y.)—An Accessory and Materiel section of the Aeronautical Chamber of Commerce was approved here July 9 at the meeting of that body's Board of Governors, and a gathering of the new group was scheduled for show week at Cleveland.

Two new committees, furthermore, were named at this meeting—one the Arbitration Committee, headed by J. C. Hunsaker, to deal with any points of difference which might arise, and the other a committee to review the relationship between the Chamber and the Society of Automotive Engineers. Insurance and production data were subjects of discussion at the gathering, with members declaring themselves in favor of a comprehensive collection of production figures by the Aeronautical Chamber.

In the semi-annual report, it was pointed out that the Department of Commerce has "approved in principle" a new code of procedure drawn up by manufacturers represented in the Aeronautical Chamber, which is aimed to bring all problems of governmental regulation before the industry for discussion. Work of the Chamber, which has grown in membership from 244 early in 1928 to 808, was cited.

Williams, Yancey Fly Atlantic

ROME (ITALY)—The Whirlwind-powered Bellanca monoplane, "Pathfinder," in which Roger Q. Williams and Capt. Lewis A. Yancey hoped to make a nonstop flight from Old Orchard, Me., to this city, was landed here July 10 at 9:30 p.m., or 3:30 p.m. New York time. The plane, which was sold originally in December, 1927, and has changed hands several times since then, took off from Old Orchard July 8 at 7:49 a.m. Eastern Standard time. It carried 445 gal. of Tydol aviation gasoline. Head winds cut down the fuel supply, however, and the plane was brought down with practically empty tanks at Santander, Spain, July 9 at 8:30 p.m. Greenwich time, or 3:30 p.m. New York time, making the flight time 31 hr. and 41 min. Santander is approximately 3,400 mi. from Old Orchard and 1,000 mi. west of Rome. The next day, the "Pathfinder" was flown to the Italian capital, landing here just 24 hr. after the landing was effected at Santander. Fog was encountered the greater portion of the distance across the Atlantic, necessitating blind flying for the most part. The plane was equipped with Pioneer instruments and carried a Boyce ice-warning device. Veedol engine oil was used.

Women's Air Derby Will Not Be Modified

TOLEDO (OHIO)—The nation's leading women fliers, it is announced here, have won their point for a Santa Monica-Cleveland air derby to be flown Aug. 18-26 in connection with the National Air Races, and men, furthermore, will not be permitted in the planes, states Herold M. Harter, secretary of the National Exchange Club, this city, under whose auspices the event is being held. The decision was reached following conferences by Mr. Harter, Floyd J. Logan, Cleveland, chairman of the National Air Races, and Frank T. Copeland, managing director of the Women's Air Derby, Santa Monica.

The rules of the race now stand that the crew of each plane shall consist of a woman pilot alone, or woman pilot and not more than one woman as passenger or mechanic. The woman riding as mechanic or passenger must be one who has never made a solo flight. Dual controls will not be permitted, according to Harter, Logan, and Copeland.

Each woman pilot must be licensed by the Department of Commerce, and hold an F. A. I. license and an annual sporting license, issued by the contest commissioners of the National Aeronautical Association of Washington, D. C.

All pilots must have had at least 100 hr. of flying experience, including 50 hr. of cross-country flight. Two classes of planes will be used, those of 110 hr. or less, and those of from 110 to 200 hp.

Announce Ryan Improvements

ST. LOUIS (MO.)—Among refinements in design of the Ryan plane recently developed by the Ryan Aircraft Corporation, this city, are a new cowling, an improved carbureter heater, an oil cooler, and an improved control system, according to anouncements. The corporation is now operating a night shift three times per week, and more men are being added to the payroll.

Form Western States Group

BOISE (IDA.)—Western States Aeronautic Association is the name of the group formed here at the Air Commerce Conference, July 8-10, attended by representatives of eleven western states. Uniformity in legislation affecting aeronautics was stressed. Another conference is scheduled for Aug. 27-28 at Salt Lake City.

Great Northern Buys Minnesota Aircraft Firm

MINNEAPOLIS (MINN.)—Mark M. Hurd, president of Great Northern Aviation Corporation, newly organized holding company to operate aviation enterprises and flying schools in the Northwest, announces purchase of the Minnesota Aircraft Corporation of Minneapolis.

The offices of the company will be moved to St. Paul and the general business conducted there under the name Minnesota Aircraft Company.

L. W. Chandler, president of the Minnesota Aircraft Corporation, will remain as president and general manager of the operating company. Mr. Chandler is one of the pioneers in the airplane sales and distributing business in the Northwest. The new concern will distribute and sell a full line of Eaglerock airplanes. It will use the St. Paul airport as a flying base.

Ryan Firm Capital $500,000

ST. LOUIS (MO.)—Ryan Aircraft Corporation, formerly the Mahoney-Ryan Aircraft Corporation prior to its recent acquisition by Detroit Aircraft Corporation, has incorporated with 1,000 shares of no par value stock, beginning business with $500,000. Edward S. Evans, of Detroit, president of the company, has 998 shares of the stock, and Howard H. Emmons, of Detroit, and John C. Nulsen, of St. Louis, each have one share. (Swarts, Reyburn & Kawin, attorneys, St. Louis.)

National Show Goes to St. Louis

Exhibit in May for N. Y.; Sanction Detroit Exposition

NEW YORK (N.Y.)—St. Louis will be the scene of the 1930 National Air Show, with February as the time, the exact dates to be set later, according to an announcement by Charles L. Lawrance, chairman of the show committee of the Aeronautical Chamber of Commerce. This means that 1929 will be without a Class A show, the Chicago Exposition last December being the last to fall in this classification.

Mr. Lawrance also announced that a New York aircraft show, to bear a Class B designation, will be held in Madison Square Garden in that city, May 3-10, 1930. Sanction and a Class B designation also went to the third annual All-American Aircraft Show, to be held at Detroit April 5-13, 1930. The New York show dates were selected upon recommendation of the Metropolitan New York Division, Distributor-Dealer Section of the Chamber, which has assured full cooperation and which desires to offer an exposition designed for the public at a time when weather is suitable for demonstrations. It is understood, incidentally, that the second annual New York Aviation Show, sponsored by the American Legion, Aviators' Post No. 743, for Feb. 5-12, 1930 will be given as planned, regardless of lack of sanction, which, it is said, has not been asked.

Chicago Show Considered

As for Chicago, Luther Bell, secretary of the Aeronautical Chamber, and Cliff Henderson, Chamber exposition manager, will leave shortly for the Illinois city, to confer with the Chicago distributor-dealer section concerning the holding of a show. An announcement will be made shortly regarding resulting plans.

The St. Louis Class A show is to be staged in the two National Exhibition Buildings under construction on Oakland Avenue, 30 min. distant from the business center of the city on the edge of Forest Park and in the center of the residential section north of the hotel district. Planes may be landed on an air field opposite the buildings and taken in without dismantling.

The buildings will consist of two units of 86,000 sq.ft. each and a covered arena between them offering 31,500 sq.ft. available for booth displays. Lambert-St. Louis Field and Parks Airport, it is announced, will be used for demonstrating planes.

Offer Whirlwind Swallows

WICHITA (KAN.)—A Whirlwind powered three-place Swallow biplane has been turned out here by the Swallow Airplane Company. According to George Bassett, general manager, this model will be built to order only.

Low-Wing Airplane Developed by Lockheed

One of the first photographs of the new Lockheed low-wing, "City of Tacoma," in which Lieut. Harold Bromley, Washington flier, plans to span the Pacific from Tacoma to Tokio, Japan. Lockheed's first low-wing carries 890 gal. of gasoline, sufficient for 40 hr. flying.

Change Plane Approval Code

Modifications Listed For Gliders, Propellers

NEW YORK (N. Y.) — Thirty-eight specific changes in the Department of Commerce airworthiness requirements—the aircraft engineering code followed by American plane manufacturers to obtain approved type certificates—are announced here by the Aeronautical Chamber of Commerce. The changes, officials state, are designed to add comfort as well as safety to planes produced in this country.

Advanced copies of the new code have been prepared by the Aeronautical Chamber and sent to its members, with the Government printing of the requirements expected to held up until early next year. A résumé of outstanding changes called for follows:

To further strengthen the construction of planes, the Department of Commerce will require manufacturers to demonstrate by tests the strength of all control surfaces and control systems and the shock absorbing qualities of the landing gears on their planes, according to officials of the aeronautical trade association. Such strength tests were not required previously.

All wood members used in airplane construction must now be tested to destruction and samples of the parts which fail must be tested to determine their physical properties.

Rule on Cabin Exits

Cabins must have one exit for every six persons carried, under terms of the new code, instead of simply two exits as formerly. Detailed specifications for all openings and exits are given the manufacturers.

The formerly sketchy requirements for the installation of engines in airplanes have been expanded to include detailed instructions to insure the highest type of construction.

Propeller clearance above the ground has been changed from a minimum of 6 in. to a minimum of 9 in. on land planes and an 18 in. clearance has been specified for seaplanes.

It is now required that propellers be so designed and adjusted that they will limit the engine speed at full throttle in level flight to 105 per cent of the official rated speed. The performance and flight test specifications have been amplified so that it describes the procedure now followed by the Department of Commerce inspectors.

The relative efficiency of biplane wings must be determined from rational formulae instead of from the curves formerly specified.

The methods for calculating air load and dead weight for wings which are tapered in thickness ratio have been changed to comply with the latest facts known to aeronautical engineers.

The introduction of glider building in the United States has prompted the addition of a new paragraph in the airworthiness requirements devoted to building these engineless aircraft.

The requirements for propellers have been rewritten to eliminate the difficulties which have been encountered in the past year. These new requirements are substantially the same as formerly, except that the Department of Commerce will no longer accept new propellers upon an affidavit of 150 hr. of flight service.

Army Fliers to "Fight" With Fairchild Cameras

NEW YORK (N.Y.)—A novel "machine gun" camera to train aerial gunners is to be developed and built under contract with the United States Army by the Fairchild Aerial Camera Corporation, a subsidiary of the Fairchild Aviation Corporation, according to announcements. The instruments are to be similar in appearance, shape, and weight to the machine guns used in aerial combat.

Air combat students engaging in a sham "dog fight" fire the "guns" at one another by pulling conventional triggers—but small photographs are clicked off rather than bullets and each picture, it is said, will show exactly where the projectile would have hit. Furthermore, the hour, minute and second at which the photographic shot was fired is to be indicated in one corner of the film.

Through comparisons of the resulting film record of "shots" and of the exact time at which they were "fired," two combatants may later determine which fighter first reached a vulnerable spot of the enemy plane.

Boston N.A.A. Sponsors Meets

BOSTON (MASS.)—In order to promote more interest in the National Aeronautic Association, the Boston chapter is sponsoring a series of flying meets to take place during this summer at the Boston Airport, and possibly at other fields in New England. The first meet was scheduled at the Boston Airport, Thursday evening, July 18. Prizes will be awarded the winners in each of the events listed and arrangements will be made for a credit of points towards a major trophy for the individual or organization winning the most points during the entire series of meets. Those interested should notify Miss L. Defren, 289 Park Street, Newton, who is chairman of the contest committee organized for the competition.

To Build Many Aristocrats

BUFFALO (N.Y.)—Manufacture of 520 "Aristocrats," 30 photographic "Surveyors," and 30 mail planes is called for on the eighteen-month schedule of General Airplanes Corporation, this city, with the period dating from June 1. This production statement has been issued by C. S. Rieman, president of the firm.

Name Kerber, Beisel To Spartan Positions

TULSA (OKLA.) — Appointment of Lawrence V. Kerber, chief of the engineering section, Air Regulations Division, Aeronautics Branch, as president of Spartan Aircraft Company, this city, is announced by W. G. Skelly, chairman of the board and president of the Skelly Oil Company. Announcement is also made that Rex B. Beisel, until recently a designer for Curtiss Aeroplane & Motor Company, has been named vice-president in charge of engineering.

Mr. Kerber, a graduate of the University of Michigan in aeronautical engineering, became chief of the aerodynamics branch, McCook Field, Dayton, Ohio. In 1927 he was named Daniel Guggenheim professor of applied aeronautics at Michigan; in 1928 he took his position with the Aeronautics Branch.

Mr. Beisel first entered aviation in 1917 in the Bureau of Aeronautics, Navy Department, and later in the design branch. In 1923, Mr. Beisel joined the engineering staff of Curtiss as design assistant. He is well known for numerous aircraft developments.

Gets Time Payment Insurance

NEW YORK (N.Y.)—Draft and signing of an aviation insurance contract to be used as the basis of its future financing of time payment sales in the aeronautical field, is announced by Commercial Investment Trust Corporation through its subsidiary, Commercial Investment Trust, Inc. The contract, announced as the result of an exhaustive study of hazards pertaining to the aero industry as well as of the legal complications imposed by state and national laws, was stated by the corporation to have been developed in cooperation with two old-line insurance companies. It is pointed out, incidentally, that many other products in the industry besides airplanes are purchased on the deferred payment plan, such as airport equipment, hangars, landing lights, meteorological stations, etc.

'Untin' Bowler Lost

NEW YORK (N. Y.)—Reports have been received that the Sikorsky 'Untin' Bowler, which started from Chicago, July 3, to fly to Berlin, Germany, by way of the Arctic, was swept away in an ice flow at Port Burwell, Cape Chidley, in the Hudson Bay region, with no one aboard. Attempts to save the plane were futile.

New Offices for United

NEW YORK (N. Y.)—United Aircraft & Transport Corporation announced on July 15 removal of its offices from 51 Pine Street, New York City, to the New York Central Building, 230 Park Avenue, New York. The phone number is Vanderbilt 5014.

Plan Aviation Exhibit At Iowa Fair in August

IOWA CITY (IA.)—Plans for Iowa's second annual Aircraft Show, to be held at the Diamond Jubilee Iowa State Fair, Aug. 21-30, and to occupy nearly twice the space of last year's air show, are announced here today by state fair officials and aviation enthusiasts who are cooperating in arranging the big display.

Leading plane manufacturers and agents are being invited to send in planes for the eight days of the Diamond Jubilee Exposition and to provide demonstrator planes at the State Fair airport. An aviation accessory show will supplement the main display of aircraft.

This year's Aircraft Show will be open to the public free of charge. Officials announced this change from last year's policy because of the widespread interest in aviation and their desire to permit as many as possible to see the exhibition of the different makes of planes.

The show will be held in the open air in a special arena 150 ft. by 300 ft. immediately adjoining the main aviation field at the fair grounds.

Developing Domestic Chute Silk

WASHINGTON (D. C.) — Specifications for a silk parachute fabric which can be manufactured in this country and which compares favorably with the foreign product, have been drawn up by the Bureau of Standards at the request of the Bureau of Aeronautics, Navy Department. Many of the domestic fabrics tested were reported entirely satisfactory and some superior to the foreign products. Investigation is being directed at present to the development of a suitable fabric woven from homegrown fibre, such as cotton, with the aim of obtaining eventually an entirely domestic product. Mercerized and doped "Arizona Egyptian" cotton has been tested.

To Test Cessna for Goebel

WICHITA (KAN.) — Cessna Aircraft Company, it is reported here, will shortly test a new high-speed plane designed for use by Col. Art Goebel in new attempts for cross-continent records. A top speed of better than 175 m.p.h. is desired of the new craft, which is built around the Pratt & Whitney Wasp engine, is equipped with a N.A.C.A. cowling, and is being provided with gas tanks availing a fuel capacity for more than 3,000 mi. flight.

Must Pay Forced Landing Damage

MUSKEGON (MICH.)—Arthur Billings, pilot and owner of a plane which damaged an automobile while making a forced landing on the beach at Grand Haven several weeks ago, must reimburse the automobile owner, according to a judgment handed down in circuit court here.

Book Salesman Uses Waco

ROANOKE (VA.)—Delivery has been made of a Waco "180" to George H. Mason, this city, agent for a set of books sold to normal school students and teachers. With his plane, the second of this type he has owned, Mason has attained the sales lead of the firm he represents. He covers a territory which includes Virginia, Georgia, Florida and North and South Carolina.

To Start Construction Of Pratt & Whitney Plant

EAST HARTFORD (CONN.) — Construction here of the new $2,000,000 plant of the Pratt & Whitney Aircraft Company, division of United Aircraft & Transport, is to start shortly, according to announcements. It is expected that the unit will be in full operation soon after the first of the year.

To consist of a two-story administration building, a personnel building, an engineering building where experimental work will be carried on, a garage, a power house, and the main manufacturing unit, the entire unit will be 400 ft. wide, 1,500 ft. long, and will contain a total area of 500,000 sq.ft.

The latest Monitor type of factory construction, such as used by General Motors and Ford in automobile production, will be employed. The flying field to be developed immediately behind the plant will be 400 acres in extent. (Editor's Note—See page 1804, AVIATION, May 25 for the announcement story concerning the new plant.)

Army 'Chute Order to Irving

NEW YORK (N. Y.)—The Irving Air Chute Co. is the successful bidder for a contract from the United States Army Air Corps for the delivery of 1140 Irvin air chutes, it has been announced by Col. L. J. Campbell, chairman of the Board of the Company. Believed to be the largest single order ever placed for safety parachutes, the contract calls for delivery over the next six months. Additional orders on hand from foreign governments and commercial air transport operators in the United States will tax the capacity of the Irving factories both here and abroad for the next eight months, Colonel Campbell reported.

Asks Duty-Free Chronographs

WASHINGTON (D. C.)—A request that imported chronographs for use on aircraft should be permitted to enter duty-free was made to the Senate Finance Committee July 9 by Edgar L. Vail, representing the Jaeger Watch Company, New York. Mr. Vail said the imported instruments do not compete with anything made in this country and that the present duty now amounts to approximately 100 per cent. At that rate of duty the Jaeger company must put a price of $60 on them but without this tax would be able to sell them for $20 or $22, said Mr. Vail.

Announce Ten Approved Floats

WASHINGTON (D. C.)—Airplane floats approved for use on licensed aircraft have been listed as follows by the Aeronautics Branch, giving manufacturer's name, model, number of floats per airplane, and the maximum allowable airplane weight, respectively: Brewster, B-5500, 2, 5,000; Edo, Type C, 2, 2,580; Edo, De Luxe, 2, 2,660; Edo, Type E-3, 2, 4,100; Edo, Type H, 2, 1,600; Edo, Type J, 2, 5,570; Edo, Type K, 2, 4,880; Fairchild, P-6, 2, 5,470; Hamilton, Series F, 2, 5,230; and Hamilton, Series D, 2, 3,840. Prior to the use of these floats on any type of aircraft, a complete investigation and approval of the particular type of installation is required.

Announce Waco Deliveries

TROY (OHIO)—Numerous recent deliveries of planes are announced here by the Waco Aircraft Company. Rankin Flying Service, Portland, Ore., Northwest distributor, has received a carload of five OX powered craft with another carload promised shortly, while Dennison Airplane Sales Company, Atlantic, Mass., has also received five OX Wacos. The American Aircraft Corporation, Southwest Waco distributor at Los Angeles, has been sent a carload consisting of both OX models and Whirlwind Taper Wings. In the export field, the firm announces recent delivery of Wacos for instruction work at Shanghai, China, and others for mail and express service in Alaska. An order for three J-5 Taper Wings has been received from Central America.

Proposes Planes for Servicing

LINCOLN (NEB.)—Sidles Airways Corporation, this city, Nebraska and Colorado distributor for Arrow and Stinson planes, is working up a sales campaign among midwest business firms that want to use planes in sending service men over territories. Telephone companies are also being approached in view of selling planes to them for use in discovering wire trouble and transporting repair men.

To Offer Seaplane Instruction

ALAMEDA (CALIF.)—A seaplane instruction base is being put under construction on a tract adjoining the Alameda air field, according to Capt. Frank M. Bartlett, district manager of Curtiss Flying Service. All necessary equipment for the teaching of seaplane work will be installed.

Seven to School Committee Posts

Meeting is Scheduled At Cleveland Air Show

NEW YORK (N. Y.)—Selection of seven members of a committee of nine pilots to study flying school problems on behalf of the aircraft industry, is announced by Frederick B. Rentschler, president of the Aeronautical Chamber of Commerce, this city. The seven men named on the new committee are: Tex Rankin, Portland, Ore.; C. S. "Casey" Jones, New York City; John Bowers, Los Angeles, Calif.; Cloyd Clevenger, Tulsa, Okla.; W. D. Haviland, St. Louis, Mo.; Oliver L. Parks, St. Louis, Mo.; and Chan C. Mason, Buffalo, N. Y. Two vacancies on the committee will be filled later, Mr. Rentschler said.

The committee will meet in Cleveland August 29, during the National Air Races and Aeronautical Exposition, to elect a chairman and formulate a program of investigation on flying school problems. The committee will work with the Department of Commerce, which is rating all flying schools under provisions of an amendment to the Air Commerce Act.

To Announce Rated Schools

The first 25 schools to be rated under the new code will be announced within a few weeks. The original committee which drafted these regulations resigned in April after having carried out its mission; the new committee named is to study further flying school problems and advance the standards.

Action of the Department of Commerce in eliminating the "one-man flying school" is disclosed in a bulletin now ready for distribution to members of the Chamber's school section. It is stated therein that transport pilots filing applications for an instructor's license, for either flying or ground work, will not be approved unless they are actually employed by an approved flying school. Transport pilots need no license for individual instruction, it is announced. As many may be taught individually as desired, but there are to be no "one-man flying schools," and licensed flying instructors must actually be on the payroll of an approved flying school.

Irving Sponsors 'Chute Film

NEW YORK (N.Y.).—Irving Air Chute Company, Inc., Buffalo, N. Y., is sponsoring the film "Happy Landings," a picture just completed by Visugraphic Pictures, Inc., this city, depicting the manufacture and use of the parachute. Slow motion photography is used to advantage in showing various jumps.

Deliver 23 Command-Aires

LITTLE ROCK (ARK.)—Twenty-three airplanes were delivered to purchasers by Command-Aire, Inc., from the Little Rock factory during the month of June.

Circus Planned at Alliance

ALLIANCE (OHIO)—Sponsored by the American Legion, plans are being completed for an air circus to be staged here July 27 and 28. Thirty planes, including a Ford and a Goodyear blimp from Akron, are to be entered in the events. Lieut. William J. Leonard, chief test pilot for the Alliance Aircraft Corporation, is taking a leading part in arranging the program, according to the announcement.

Control of Coast Firm Goes to Talbot Interests

PORTLAND (ORE.).—Control of West Coast Air Transport has been acquired by a group of California capitalists headed by James Talbot, chairman of the board of directors of Richfield Oil Company, and Harris M. Hanshue, identified with W. A. E. This statement was made by Charles V. Eakin, president of West Coast, after rumors had been afloat for several days telling of the sale of the company.

The transaction amounted to a refinancing whereby West Coast would have funds for improving its equipment and expanding, Eakin said. He further announced that ten tri-engined Fokker F-10's would be placed at the company's service in July. Plans for extending the line to reach British Columbia and Southern California were also given out.

West Coast was organized by Eakin more than a year and a half ago. Since March 5, 1928, the line has carried on a passenger and express service between Seattle, Portland and San Francisco. Portland will remain the headquarters of the company.

Report Davis V-3 Deliveries

RICHMOND (IND.)—Davis V-3 monoplanes, manufactured here by the Davis Aircraft Corporation, have recently been delivered to the following: Jack Frye, president of the Aero Corporation of California, Los Angeles; Cole & Sons Motor Company, Carbondale, Ill.; Howard Rinehart, president of Dayton Air Institute, Inc., Central and Western Ohio distributor; and W. A. Simms, Dayton, Ohio. New orders were placed by Cole & Sons Motor Company, by Dayton Air Institute, and by Thomas D. Lane, of St. Paul, Minn.

Simplex Aircraft Absorbed

DEFIANCE (OHIO)—Simplex Aircraft Corporation, this city, has been absorbed by the Aero Corporation of America, chartered in Delaware. The new company will acquire all of the stock of the Simplex corporation and nearly all of the bonds and stock of the Covert Gear & Manufacturing Co., of Lockport, N. Y. Expansion of the Defiance firm and airport is expected to result from this newly-announced combination.

American Eagle Buys Wallace Aircraft Firm

KANSAS CITY (MO.)—Wallace Aircraft Company, Inc., of Chicago, has now been purchased by American Eagle Aircraft Corporation, Kansas City, according to E. E. Porterfield, president of the latter concern. The Wallace firm has been producing the "Touroplane," a three-place, Kinner-powered folding wing, cabin monoplane.

The Wallace company is the first aircraft manufacturing concern to be acquired by the American Eagle firm following its organization recently of the subsidiary company, Porterfield Aviation Interests, Inc., a holding company for several aircraft building and aeronautical accessories firms purchase of which is contemplated.

While the purchase figure was not announced by Mr. Porterfield, it is believed to be approximately a quarter million dollars. Removal of the Wallace factory to Kansas City will be in August. Until then Wallace Touroplanes will be constructed in Chicago and delivered to purchasers from that city.

The name Wallace Touroplanes will be retained by the American Eagle company and the company henceforth will be known as the Wallace Aircraft Company, Inc., a division of the American Eagle Aircraft Corporation. C. E. Thompson is president of the Wallace company and Stanley Wallace, designer and general manager.

The Wallace Touroplane, which cruises at 100 m.p.h. and has a high speed of 115 m.p.h., is manufactured under approval certificate No. 119. Mr. Wallace is now at work on a four-place cabin monoplane to be built along the same general lines as the Touroplane. This is to be added to the American Eagle line.

Plan New Tests With Prestone

DAYTON (OHIO)—A series of flights, with ethylene glycol substituted for water cooling and from which new speed marks are expected, are scheduled to be conducted at Wright Field within the next several weeks. The cooling fluid, which allows use of a smaller radiator thus reducing both weight and wind resistance, has been the object of much experimentation on the part of Army Air Corps engineers here. The chemical is sold by the National Carbon Company under the name Prestone.

Consolidated Orders Reported

NEW YORK (N.Y.).—Consolidated Instrument Company, this city, announces two orders for aircraft instruments amounting to more than $63,000. Command-Aire, Inc., Little Rock, Ark., contracted for 500 complete custom-built instrument panels, which consist of five types, to be exclusive in Command-Aires. The second order came from American Eagle Aircraft Corporation, Kansas City, specifying 200 air speed indicators and 200 compasses.

PERSONNEL

F. R. HILL has been appointed sales manager of the Okay Airplane Company, Oklahoma City.

J. F. NEWBAUER has been appointed manager of the Texarkana, Ark., Municipal Airport with full charge of maintenance and operation.

BYRON HATCH has been appointed test pilot for the Monocraft Corporation of Moline, Ill.

REGINALD ROBBINS has been appointed sales representative for the Ponder Aircraft Company, Fort Worth, Ryan representatives in Texas and Oklahoma.

DR. J. A. TAMISIEA is commercial flight surgeon for the Boeing system.

EDWARD A. STALKER is to be a member of the Arrow Aircraft & Motors Corporation of Lincoln, Neb.

SAM C. BREDER has been appointed sales manager of Lockheed Aircraft Company, Burbank, Calif.

MELVIN BEKINS, H. M. BALDRIGE, SAM A. HOUSER and J. T. STEWART, II, are directors, in addition to WALTER F. HALLEY, of Rapid Aviation, Inc., a subsibiary of Rapid Airlines Corporation, Rapid City, S. D., a unit controlled by Halley Air Management, Inc.

GEORGE T. LEACH has been elected director of the Berliner-Joyce Aircraft Corporation, Baltimore, Md.

VERNE HEDGE has been elected chairman of the Lincoln, Neb., Aviation Advisory Board.

CAPT. FLOYD SHUMAKER has been named director of the Nebraska Flying Service, Fremont, Neb.

M. E. CALLANDER has been elected general sales manager for Central Airlines Division of Universal Aviation Corporation, a unit of The Aviation Corporation.

GEORGE LEA LAMBERT has been appointed vice-president of the Von Hoffmann Aircraft Company in charge of field activities at St. Louis.

DR. MAX M. MUNK has joined the engineering department of the Alexander Aircraft Company, Colorado Springs.

T. EDWARD HAMBLETON has been elected director of the Consolidated Instrument Company of America, Inc.

R. W. PROCTER, who was formerly connected with Black and Decker, has become sales manager of The Van Dorn Electric Tool Company. Mr. Proctor succeeds Lyman H. Bellows.

J. M. BEGGS, formerly connected with the sales department of The Van Dorn Electric Tool Company, has been placed in charge of the advertising department of that concern.

WILLIAM F. WUNDERLICH, well-known air mail pilot, has been made manager of the new municipal airport at Denver, Colo.

JOHN JOHANSEN has become chief airplane and engine mechanic for Universal Aviation Corporation, St. Louis, Mo. He was formerly connected with Fokker Aircraft Corporation of America.

E. L. MCMILLAN, who was formerly with the Vance Air Service, Great Falls, Mont., has joined the staff of Universal Aviation Corporation as chief pilot.

WILLIAM H. PFLUEGER, a graduate of one of the schools operated by Universal Aviation Corporation, has been appointed assistant purchasing agent of the company with headquarters at Lambert-St. Louis Flying Field.

HARRY H. HAMMILL, Detroit, Mich., has been appointed district sales manager of American Eagle Aircraft Corporation for Ohio and the neighboring Middle Western states.

New Firms Announced

AVIATION ENGINEERING CORPORATION, 225 West 57th Street, New York City; $250,000; James V. Fonel, vice-president; to manufacture aircraft.

SULLIVAN AIRPORT, INC., 7901 Fourth Avenue, New York City; capital 500 shares no par value stock; by Frederick A. Schrader, Louis L. Cantwell, Jean Stabin; to operate an airport.

UNITED AIRPORT EXPORTS, INC., 55 Wall Street, New York City; capital $100,000; by William D. Howe, Frederick W. Jackson and Robert N. West; to deal in aircraft and transport merchandise.

AURORA AIRCRAFT ASSOCIATES, INC., 841 East 167th Street, New York City; capital $250,000; by Arthur Epstein, George Rockman, Alexander Gremm; to manufacture aircraft.

CUMBERLAND AIRPORT, INC., 213 North Calvert St., Baltimore, Md.; 10,000 shares no par value capital stock; James G. Nagel, Elizabeth Sullivan and Almyra Manning; to deal in airplanes and flying fields.

STUART AERO PRODUCTS, INC., St. Louis, Mo.; 500 shares no par value stock; Ainsley E. Stuart; E. L. Wehmeyer and Ethan A. H. Shepley; to deal in airplane parts and accessories.

AERONAUTICAL CALENDAR

July 16-27	International Aircraft Exhibition of the Society of British Aircraft Constructors, Olympia, London.
Aug. 24-Sept. 2	National Air Races and Aeronautical Show, Cleveland, Ohio
Aug. 26-28	Society of Automotive Engineers, Cleveland Aeronautic Meeting.
Sept. 2-7	Class C Aviation Exhibit Rochester Exposition at Rochester, N. Y.
Sept. 6-7	Schneider Cup Race, over the Solen Cowes, England.
Sept. 23-28	Fourth Annual New England Aviation Exposition, Boston Garden, Boston, Mass.
Sept. 28	Gordon Bennett Balloon Trophy Race, St. Louis, Mo.
Oct. 5-21	National Air Tour, Starting from Ford Airport, Dearborn, Mich.
Oct. 12-27	Southwestern Aircraft Exposition, State Fair Grounds, Dallas, Tex.
Oct. 31	Guggenheim Safe Aircraft Competition closes.
Nov. 18	Lehigh Airport Design Competition closes. Lehigh Portland Cement Company.

Schools and Colleges

GREAT NORTHERN AVIATION CORPORATION, St. Paul, Minn., formally opened the Great Northern Aviation Schools at St. Paul on July 15. The new institution which includes both ground and air instruction is regarded as one of the largest schools in the Northwest and is under the direct supervision of Mark M. Hurd, president of the Corporation. The Ground School is housed in the Great Northern Aviation Building, 568-80 University Ave., St. Paul. The manual of school courses includes six ground and three flying courses as follows:

Private pilot's ground course, Limited Commercial pilot's ground course, Transport pilot's ground course, Aviation mechanic's course (days), Aviation mechanic's course (nights), Private pilot's flying course, Limited Commercial pilot's flying course, and Transport pilot's flying course.

LINCOLN AIRPLANE SCHOOL, Lincoln, Neb., plans to spend approximately $50,000 during the summer in enlarging its school. A quarter section of ground, ten miles from the city will be purchased for an airport, according to E. J. Sias, director, and new hangars will be constructed and other equipment under the Department of Commerce ruling for a recognized Transport School.

BENNETT FLYING SERVICE, Kansas City, Mo., has organized a branch school at the new Henryetta municipal airport.

MUTUAL FLYERS CLUB, INC., Lincoln, Neb., which boasts of a membership of 78 has purchased a three-place Lincoln-Page and is conducting a flying school at the municipal airport where the Club has erected a temporary hangar.

CENTRAL AIRLINES SCHOOL, Wichita, Kan., is offering a specialized business course given by the officials of the School and based on their experiences in the industry. The course covers a period of 10 weeks. A class in welding has also been started by Central, and 30 students are now enrolled.

UNIVERSAL FLYING SCHOOL, Memphis, Tenn., recently started its first night mechanic's and pilot's ground course. The Memphis-Universal school was opened the latter part of last month, and the night courses are being held on the third floor of the West Court Building. In addition to the night courses the Company has formed a business class in aviation for both men and women. This training is also to be given at night. Universal also announces that work is under way at Wold-Chamberlain Field, Minneapolis, on a $30,000 school building to be ready late this month.

CURTISS FLYING SERVICE OF INDIANA, opened its fourth ground class at Indianapolis July 12. Nearly 40 were enrolled.

Trade Division Headed by Rogers

Barker, York, Rea Named as Assistants

WASHINGTON (D.C.) — Because of the growing importance of the export market to American manufacturers of aircraft and accessories, the Commerce Department has established an Aeronautical Trade Division, it was announced recently. Leighton W. Rogers, who was formerly American Trade Attache at several European capitals and who acted as executive officer of the International Civil Aeronautics Conference last December, has been named as director of the new division.

Mr. Rogers is a major in the Air Corps Reserve and was in charge of the Department's activities for developing overseas markets for aircraft products when this work was under the Transportation Division. He will be assisted by Fowler W. Barker, Brower V. York, and C. D. Rea, Mr. Barker was on the staff of the International Aeronautics Conference and has had experience in the aviation industry as a pilot and in sales work.

As an indication of the growth of the foreign trade, it is stated that preliminary reports for the month of May show that exportations of aeronautical products were the greatest amount ever recorded. The cooperation of the 63 foreign offices of the Commerce Department and the consulates throughout the world will make it possible for the new division to keep the domestic industry informed of foreign activities and markets.

Particular attention will be given to the compilation of data on rates, schedules, and operating results of foreign airlines. Foreign traffic regulations and aviation insurance methods will be studied also. The division will be divided into two sections. The trade section will be headed by Mr. Barker and will deal primarily with the most effective methods in building up foreign markets and in avoiding distribution wastes. The other section, of which Mr. York will be the chief, will compile and disseminate information relative to foreign aeronautical activities.

Boston Votes Aero Bureau

BOSTON (MASS.)—In order to enlarge the scope of aviation activities of the Boston Chamber of Commerce, the board of directors of that organization has voted to create an aviation bureau. Hitherto these activities have been conducted under the management of the civic bureau. Theodore G. Holcombe, an assistant in the civic bureau, has been appointed manager of the new department and will have general charge of the work in co-operation with the Chamber's committee on aviation. James D. Brennan of the First National Bank of Boston is chairman of that committee.

Colorado Fruit Shipped by Plane

DENVER (COLO.) — Six hours after raspberries were picked in Colorado they were eaten in Kansas City by virtue of a recent airplane shipment over the distance of more than 600 mi. Fred Green, of Green Brothers Fruit Company, this city, sent the berries as an experiment, and he is now of the opinion that a satisfactory business on perishable shipments may result if the transportation firms can offer a suitable rate.

Georgia and Indiana State Tours Scheduled

Two state air tours are reported on the calendar. The All-Georgia Air Tour begins at Atlanta July 24, with 38 cities on the itinerary. It is sponsored by the N.A.A. chapter at Atlanta and by the Atlanta *Constitution*.

According to preliminary plans 40 planes will make a state tour of twenty Indiana airports the week of Sept. 16. The Indianapolis Aircraft Trade Association is sponsoring the flight and the following committee has been appointed by Capt. H. Weir Cook, of Indianapolis, president of the association: Harold C. Brooks of Indianapolis, chairman; C. F. Cornish of Ft. Wayne, Ellis Fish, of Bedford, Lawrence Artez of LaFayette, Paul Cox of Terre Haute, L. D. Miller, of Richmond, and Clyde Shockey, of Kokomo.

Test J-5 Eagle Phaeton

KANSAS CITY (MO.)—Completion is reported here of tests by Aeronautics Branch representatives on the new American Eagle Phaeton, a three-place biplane powered with the Wright Whirlwind J-5 220-hp. engine. Production of the plane by the American Eagle Aircraft Corporation is now under way. Built along the same general lines as the 165-hp. Wright-powered Phaeton, the J-5 craft employs the new type tail surfaces and has staggered wings with steel tubing "N" type interplane and center section struts. It has an estimated cruising speed of better than 120 m.p.h.

Navy Order to Great Lakes

CLEVELAND (OHIO)—The Navy has given an additional order for $50,000 worth of pontoons to Great Lakes Aircraft Corporation, Cleveland, it is announced by Col. Benjamin F. Castle, president. This order is in addition to the one for eighteen three purpose battle planes and other equipment totalling approximately $650,000 given Great Lakes recently.

Announce Cleveland Show Gliding Events

DETROIT (MICH.) — The National Glider Association, with headquarters here, has sanctioned the holding of the first official glider contest under the auspices of the N.G.A. during the National Air Races, scheduled for Aug. 24 to Sept. 2 at Cleveland, Ohio. In conjunction with the contest there will also be held the Second National Glider Conference on Aug. 27 at the Winton Hotel, Cleveland. The Conference will be under the joint auspices of the N.G.A., the Cleveland Glider Club and the sponsors of the National Air Races.

Among the events to be held in the glider contest are the following:

(1) Distance, shock-cord launching method.

(2) Duration, shock-cord launching method.

(3) Distance, auto-towing launching method.

(4) Duration, auto-towing launching method.

(5) Landing on a mark, auto-towing launching method.

(6) Famous Motored pilots' Derby, auto-towing launching method. Duration and landing on a mark to count, each 50 per cent.

(7) Best all-around handling of a glider for glider pilots only.

(8) Best all-around handling of glider, any pilot.

Individuals and clubs desiring to enter for the contest will be paid 10c. a mile each way from their home to Cleveland, toward the expense of bringing their glider or gliders to Cleveland, the maximum sum to be paid owner of any one glider being $100. Inside hangar space will be available without cost, properly guarded or barred at night and repair equipment and tools will be available without cost. To secure expense money, the owner or owners of the glider must actually enter and fly in the contest on at least two days. Any ships entered and suffering a bona fide washout will receive contest money regardless of length of time flown.

Entries for the contest should be made by writing to L. F. Ross, c/o the Cleveland *News*.

Plan Kansas City Show

KANSAS CITY (MO.)—An Air Circus, Exposition and Pilots Reunion, to be held at Fairfax Airport, this city, Sept. 21-29, has been announced. The United States Army Air Corps Reserve Officers Association is slated to be in charge. The air circus will be featured by stunt flying, balloon strafing, maneuvers by bombardment and pursuit squadrons, sky writing, refueling airplanes in flight, radio communication from plane to ground, aerial ambulance demonstrations, flights by air liners, parachute jumping, aerial fireworks, demonstrations of commercial airplanes, air derbies, handicaps, contests and various types of air races, accordingg to the announcement.

BRIEFLY

The Porter-Cable Machine Company, Syracuse, N. Y., has bought and will continue the manufacture of the Emmert oscillating spindle sander formerly manufactured by the Emmert Manufacturing Company, Wayhesboro, Pa.

The Airways communication radio stations at Oakland, Fresno and Glendale, Cal., and the model airway between Oakland and Los Angeles have been put in operation.

Wichita Boy Scout Council is forming several troops of air scouts, instruction being in the ground subjects.

Universal planes operating out of St. Louis carried 358 passengers in June. Students put in 700 hr. flying time.

Universal has taken a long term lease on the first floor of a downtown St. Louis Building for use as a ticket office.

Five Eaglerock biplanes powered with Hispano-Suiza engines have been received recently by L. L. Brunning, Portland, Ore., distributor.

What is called the first annual Airfair is to be held by the Sioux Falls, S. D., Chamber of Commerce, on Sept. 16-21.

W. C. Dance, Oklahoma City, is in charge of the air show in connection with the Oklahoma States Fair in September.

Complete sound and talking equipment will be carried by the South American Trade Extension plane on its tour of South America this fall.

A new edition of the Gargoyle Mobiloil aero chart has been issued by the Vacuum Oil Company.

Universal is operating a pontoon equipped Fairchild at Lake Minnetonka, Minn., for the use of fishermen and hunters.

Six hundred and twenty-seven passengers were carried on the Boston-New York service of Colonial Air Transport in June.

American Eagle Aircraft Corporation, St. Louis, Mo., will shortly produce a strictly training service type biplane for use by flying schools.

P. G. Johnson, president of Boeing Airplane Co., was one of a committee of five men representing the National Association of Airplane Operators which recently conferred in Chicago with representatives of the Post Office Department on the subject of a possible revision of air mail rates.

The airport at Superior, Wis., which was dedicated July 4, as the Arrowhead airport, has been changed to the Superior Municipal Airport by a unanimous vote of the city council.

Both ground and flying instructions with air mail pilots as tutors will be given in the school department of the Colonial Flying Service, which is establishing units throughout the territory covered by the Colonial Airways System.

E. E. Porterfield, president of American Eagle Aircraft Corporation, has announced that his company has already bettered its July production record of 1928. He expects the total 1928 figure to be passed by September first.

The Hamilton company, Milwaukee, has increased the production of its propellers from 400 a month last January to 800 monthly at present.

The Studebaker Corporation, South Bend, Ind., is delivering a fleet of 12 large cars to Transcontinental Air Transport for use on its 48 hr. coast to coast service.

Registration of the American Eagle trade-mark in Canada is announced by D. L. Chick, treasurer of American Eagle Aircraft Corporation. The trademark is now registered in practically every country in the world.

Paul Busch, of Berlin, Germany, who is now in this country studying economic and transportation conditions arrived in Chicago last week on a trip from the Coast. He commented most favorably on American progress without government subsidy.

Definite plans of the newly organized National Aircraft Company of America, Chicago, Ill., are expected to be revealed at an early date. The company has leased 996 acres 56 mi. from Chicago and just east of the Indiana line where a factory will soon be constructed for the manufacture of planes ranging from two-seater to tri-engined type.

Sixty eight students are now taking instruction at the Everett, Wash., airport. Both ground courses and air courses are available.

Word has been received by the American Aeronautical Corporation, New York City, that Roger Q. Williams and Capt. Lewis A. Yancey, plan to return from Italy to the U. S., via a Savoia-Marchetti S-55 flyingboat. No details of the route to be flown have been received as yet.

A. H. Heermance, municipal aviation director for the city of Miami, Fla., has received word from the National Aeronautic Association that that body would approve aviation contests to be held during the Miami motor boat regatta scheduled for March of next year. The N.A.A. is reported to have also approved the Miami All-American air races set for Jan. 13-15, 1930.

Curtiss Flying Service of Chicago, Ill., has increased its flying equipment by the addition of another Sikorsky Amphibion. The other Sikorsky plane has been in the local mail service for the past month.

As AVIATION goes to press, Dale Jackson and Forrest O'Brine test pilots for the Curtiss Robertson Airplane M'f'g Company are spending their third day aloft over Lambert Field, St. Louis, in a Curtiss Robin in a refueling flight to test the Challenger engine. It is not anticipated that any effort will be made to break the present record.

A committee composed of 22 prominent citizens interested in aviation has been named by Paul Wick, head of Ohio Air Transport, to function as a Citizen's Aviation Committee.

TRADE TIPS

It has been reported that

"Tex" Rankin will appoint a number of dealers in California to handle the line of planes manufactured by Great Lakes Aircraft Corporation, Cleveland, Ohio.

Bids on the construction of a building designed for the manufacture of aircraft are being received by The Beacon Airways of America, Inc., Board of Trade Building, Kansas City, Mo. The structure is to cost $100,000 and is to measure 60 x 100 ft.

The Rapid Air Lines, Inc., Rapid City, S. D., is considering the removal of its headquarters to another place where flying field facilities are better.

The Fairfax Airport Company, Fairfax Field, Kansas City, Mo., is receiving bids on the construction of a hotel and shop building to be two stories in height and to have a basement. It is to measure 56 x 160 ft.

A 60 x 80 ft. hangar and administration building is to be erected soon by The Wichita Falls Air Transport Company, Wichita Falls, Tex.

Commissioner Noyes expects to install a model lighting system at the Omaha, Neb., municipal airport.

Sabine Airways, Inc., Beaumont, Tex., has completed plans for the purchase of equipment for a nationally advertised flying school that it is shortly going to establish.

Representatives Named

AVIAN—Air Sales, Inc., 185 Devonshire St., Boston; for New England. Ludington-Philadelphia Flying Service; for territory surrounding Camden, N. J., and Philadelphia, Pa. The Wilkes-Barre Wyoming Valley Airport Company; for five counties of Northeastern Pennsylvania. Main Aeronautics Company, for Pittsburgh, Pa. Earle Lansing Jones, San Francisco; for the West Coast as far south as Bakersville, Calif. Russell W. Simpson, Clover Field, Los Angeles, Calif.; for Southern California. C. H. Quackenbush, Cleveland, Ohio; for State of Ohio.

ROBIN—Iowa Airways Corporation, Junior Chamber of Commerce, Airport, Ft. Dodge, Ia.; local agency.

UNIVERSAL AVIATION CORPORATION—The St. Joseph Air Service, St. Joseph, Mo.; for territory surrounding St. Joseph.

AMERICAN EAGLE — The Roosevelt Motor Sales Company, Lombard, Ill.; for that territory.

MOTH—Charles H. Armstrong, sales director for Huntington Aircraft Company, Bridgeport, Conn.; for that section.

DAVIS—Cole and Sons Motor Company; for Southern Illinois and Western Kentucky.

BIRD—D. Barr Peat, former manager of Bettis Field; for Western Pennsylvania.

AIRPORTS AND AIRWAYS

United Plans 30-Hr. Transcontinent Line

Boeing and Stout Service To Be Co-ordinated Oct. 1

NEW YORK (N. Y.) — United Aircraft & Transport Corporation expects to come close to its goal for establishing the first all-air transportation system across the continent about October 1. On or about that date it will launch, through two subsidiaries—the Boeing System and Stout Air Services a day and night service between San Francisco-Oakland and Cleveland. The remaining 400 mi. between Cleveland and New York City will be opened as soon as terminal arrangements and airway surveys can be made.

When the complete line is in operation it is hoped that a 30-hr. schedule will be maintained. This calls for continuous flying for the entire route, there being no railroad accommodations except in case of emergencies. At the outset, at least, "sleeper" planes will not be provided but the passengers will have the benefit of reclining chairs.

Schedule Adjustment Necessary

Inauguration of the transcontinental service as far east as Cleveland will call merely for little more than installation of additional equipment and the co-ordination of schedules between the Boeing and Stout planes, since these two concerns are operating passenger lines over this much of the route already. Boeing is flying the San Francisco-Chicago leg and Stout is flying the Chicago-Cleveland leg.

The former at present is using Boeing 80's, twelve-passenger tri-engined (Wasps) transports, of its own manufacture on the San Francisco-Salt Lake City section, and is carrying passengers the rest of the way to Chicago in mail planes fitted with passenger compartments. Stout, of course, is using Ford tri-engined (Wasps) transports on the Chicago-Cleveland section. An adjustment of schedules between the two companies and the installation of tri-engined Boeings on the Salt Lake City-Chicago section will be the major steps required to launch the line.

To Use Twelve 80-A's

Boeing will use a fleet of twelve of its Boeing 80-A's on the service. This is an eighteen-passenger tri-engined transport developed from the first of the series designated as the 80. In addition to the passengers it carries two pilots and a steward. It has a span of 80 ft., is 55 ft. long and weighs eight and one-half tons when loaded. Three Hornets make possible a crusing speed of between 115 and 120 m.p.h. and top speed of about 135 m.p.h.

Passengers will change planes at the Chicago junction of the Stout and Boeing lines and again at Salt Lake City, the half way point of the distance between the Great Lakes and the Pacific Coast. One of the reasons for this change is that machines making the climb westward to the high altitude of Salt Lake City will have a different propeller settings.

Already there are the following transcontinental services in operation: T.A.T. 48-hr. air-rail system (of the Curtiss-Keys group) between New York and Los Angeles, in co-operation with the Pennsylvania Railroad and the Atchison, Topeka & Santa Fe; Universal 60-hr. air-rail system (a subsidiary of The Aviation Corporation) between New York and Los Angeles, in co-operation with the New York Central and the Santa Fe; the Western Air Express 45-hr. air-rail system between New York and Los Angeles, in co-operation with the New York Central, the Santa Fe and the Chicago & Alton railroads; and the Southwest Air Fast Express-Standard Airlines system, through the Southwest, in co-operation with the New York Central and the Texas & Pacific railroads.

S.A.T. Considering Air-Rail Line to Mexico

FORT WORTH (TEX.)—An air-rail hook-up which involves the inauguration of an air passenger line from Palestine, Tex., to Brownsville, Tex., where it would connect with the lines of the Mexican Aviation Corporation is being considered by Southern Air Transport.

The plan of Mexican Aviation Corporation, according to Jack C. McDermott, Texas representative of the concern, is to transfer passengers from the Missouri-Pacific train at Palestine to the S.A.T. plane for Brownsville. Fifty-one-hour service between Palestine and the Panama Canal Zone will be provided, if plans for the line go through, as the S.A.T. passengers will transfer at Brownsville for Guatemala City and thence for the Canal Zone. The Brownsville-Guatemala City line goes into operation when delivery is made on tri-engined Fokkers now on order.

Three New Airways Completed

WASHINGTON (D. C.)—Three airway development projects of the Aeronautics Branch were reported completed recently. One is the Jacksonville-Atlanta section of the Miami-Atlanta airway and the other two are the La Crosse-Twin Cities and Lexington-Omaha airways.

Air Mail Shows Big Gain in June

WASHINGTON (D. C.)—Air mail poundage gained 5,783 lbs. in June over the record for the month of May in spite of the fact that June has one less day and included five Sundays. The increase in scheduled daily mileage was due to additional trips on some of the routes.

Preliminary figures, showing the poundage by routes, are as follows:

	Miles	April	May	June
Boston-N. Y....	192	7,519	10,894	11,249
Chicago-St. L...	278	6,745	6,874	7,480
Chicago-Dallas..	1,059	29,310	31,724	31,571
Salt L.-Los Ang.	600	53,906	61,558	60,720
Salt Lake-Pasco.	530	16,078	17,881	17,751
Seattle-Los Ang.	1,141	18,794	21,232	22,178
Chicago-Minn...	503	10,860	11,665	11,977
Cleve.-Pitts.....	123	11,802	6,319	5,891
Chey.-Pueblo...	199	6,800	8,539	8,952
Cleve.-L'ville...	345	6,160	9,515	10,581
N. Y.-Chicago..	718	118,327	133,830	141,104
Chicago-San F...	1,932	128,314	150,947	148,487
N. Y.-Atlanta....	763	22,149	30,069	30,840
Albany-Cleve...	446	8,311	9,088	8,170
Dallas-Galv.....	320	3,737	4,785	4,891
Dallas-Browns..	529	6,975	7,716	6,703
Atlanta- New O.	483	7,009	8,852	9,698
Chicago-Cin....	270	5,537	6,881	4,342
Atlanta-Miami..	736	9,366	8,907	8,271
G. Falls-Salt L..	489	3,970	6,799	7,300
Chi.-Bay City...	712	14,783	15,565	17,342
St. L.-Omaha...	403	0	4,228	4,198
New O.-Houston	319	3,458	4,655	5,304
Chi.-Atlanta....	768	8,764	8,948	8,254
Total.....	13,858	508,672	587,471	593,254

Scheduled daily mileage, June, 38,689.
Increase June over May—5,783 lb.
Daily average: May—18,950 lb.; June—19,775 lb.

Great Beacon for Chicago

CHICAGO (ILL.)—A 2,000,000,000 cp. revolving beacon is to be installed immediately at the top of the new Palmolive Building, 919 North Michigan Avenue, it has just been learned here. The new light, which will be known as the "Lindbergh Beacon," makes use of a 150-200 amp. high intensity arc. The light will make three complete revolutions a minute. The placing of the beacon, which is some 10½ mi. from the Chicago Municipal Airport, is said to be in accord with the recommendations of the Chicago Aero Commission and the various transport lines operating to and through the city.

Akron Firm Adding Services

AKRON (OHIO)—Middle States Air Lines, Inc., which has just opened up a passenger service connecting Akron and Pittsburgh will increase its Detroit service. The company will run two trips daily to and from Detroit. Under the new schedule on the Detroit line a plane will leave Akron daily at 8:30 a.m., arriving in Detroit at 9:50 a.m. The return plane will leave Detroit at 10:30 a.m., arriving at Akron at 11:50. The second plane will leave Akron at 3:15 p.m., arriving in Detroit at 4:35 p.m. The return plane leaves Detroit at 5 p.m., arriving in Akron at 6:20 p.m.

U. S.–Guiana Mail Line Inspection Under Way

NEW YORK, (N. Y.)—As a final preparation for the extension of the U. S. air mail service to Dutch Guiana, and thereby completing two-thirds of the American air transport system over the East Coast route between New York and Buenos Aires, an official inspection flight was started from Miami, Fla., on Monday, July 15. The route of the inspection flight was via the West Indies and the Leeward and Windward Islands.

With the establishment of the new extension there will be completed, with the exception of the link through Brazil, two great trunk airlines, of Pan American Airways system from North to South America, thus tying together 24 countries on direct airlines with the United States. Regular service over the route to Paramaraibo will provide a four-day service between the U. S. and Dutch Guiana now two to three weeks distant by the fastest steamer service. Actual service will be inaugurated on August 29 under Post Office Department air mail contracts.

Pan American Airways also plans shortly to extend service down the remainder of the East Coast of South America to Para and Rio de Janiero, Brazil, and Montevideo, Uruguay. At the latter city the P.A.A. line will link up with the line of Pan American-Grace Airways, an affiliated company and operator of the U. S. air mail route down the West coast of S. A. as this line is to be extended over the Andes to Buenos Aires and Montevideo. When this comes to pass Buenos Aires will have two separate lines to the U. S. One via the East Coast and one via the West Coast, as well as intermediate transport service to 24 countries served by P.A.A. lines.

Three Radio Beacons Assigned Frequencies

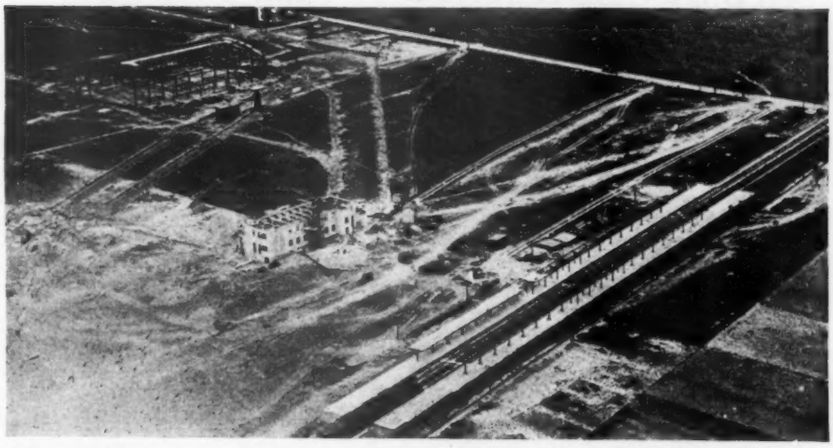
WASHINGTON (D. C.)—Radio stations used for broadcasting weather reports at Hadley Field, New Brunswick, N. J., Bellefonte and Cleveland, Ohio, are now being operated on the frequencies assigned the radio beacons at those places and will be operated on those frequencies until further notice, it has just been announced by F. C. Hingsburg, chief engineer, Airways Division, Department of Commerce.

In order to broadcast the weather reports the beacons are shut down for three minutes on the even hour while the weather information is sent out.

S.A.T. Loads Increase

FORT WORTH (TEX.)—Southern Air Transport Flying Service, Inc., operating figures for June show an increase of 50 per cent over the month of May. During May, 225 passengers were carried and during June 562 used the passenger lines. More than 81,000 mi. were flown.

Buildings at New Port Columbus Field



The buildings that serve the air-rail service of Transcontinental Air Transport at Port Columbus, the Columbus, Ohio, Municipal Airport which was officially dedicated during a special air program July 6-8. In the foreground are the covered platforms along the tracks where the passengers board and leave the trains. In the middle foreground is the municipal passenger station and operations office. A canopy now extends from this structure to the railroad station. In the distance is the T.A.T. hangar in process of construction.

Meacham Field Reports Profit

FT. WORTH, (TEX)—Meacham Field, which is municipally owned and operated, showed a profit of $6,951 for the nine month period ending June 1. Gross income for that time totaled $17,671.16, while total expenses were $10,719.50. The income was realized from the sale of gasoline, oil and parts, storage fees and repairs.

Royal Airways Begins Improvement Program

MADISON (WIS.)—The Royal Airways Corporation, operator of Pennco Airport here has purchased the site and will launch an immediate $60,000 improvement program. The new program calls for an increase in the capitalization from $30,000 to $200,000.

Improvements to the field, which will have a length of 7,450 ft. includes a new 100 x 120 ft. hangar. A government accredited flying school will be established and orders have already been placed for five Monoprep planes to be used daily for instruction work. The Company has also ordered one of the larger models made by the same firm. Officers of the Royal Airways Corporation are E. N. Quinn, president; Howard Morey, vice president; A. C. Breuch, treasurer; Glenn W. Stephens, secretary.

Ludington Opens Line

PHILADELPHIA (PA.)—A week-end passenger service linking Philadelphia and New England summer resorts was started June 5 by the Ludington Cape Cod Airway.

Pacific Air Transport Reduces Airline Fares

SAN FRANCISCO (CALIF.) — Summer excursion rates are now making their appearance in relation to air transportation. Pacific Air Transport, the unit of the Boeing system which operates an airline along the West Coast, has announced substantial reductions in fares during the summer months. The flight from Seattle to Los Angeles, which normally costs $125, has been reduced to $75, while the cost of the trip from this city to Seattle by air is now $50 instead of $80, and the flight from San Francisco to Los Angeles is now but $25, rather than $45.

Coincidental with the announcement of the summer reductions in rates, Pacific Air Transport has announced a speeding up of the service from Seattle to Los Angeles. The northbound trip is now made in 1 hr. and 45 min. less time than formerly, while 1 hr. and 15 min. has been cut off the southbound flight time. The planes used by Pacific Air Transport are four passenger, Boeing cabin machines. The "Wasp" engines now used in these planes are rapidly being replaced with "Hornets."

Summer Rates for Boeing

SAN FRANCISCO (CALIF.)—Summer passenger rates on its coastwise routes, effective for a period of 90 days beginning July 1, have been announced by the Boeing System. New rates from this city to Los Angeles, Medford (Ore.), Portland, Seattle and Fresno (Calif.) are, respectively, $25, $30, $40, $50 and $15, as against $45, $40, $68, $80 and $20.

Report Additional Airport Construction

Development Work Continues in Many Places

A fund of $5,000,000 is to be sought for expansion work at the Pensacola, Fla., naval air station during the coming year, according to Congressman Yon, of Florida. A. F. Youngberg, of Leonard McCumber, Inc., Chicago aviation engineering concern, is making a survey of sites for a Muncie, Ind., Municipal Airport.

Grading of runways has been started at the Evansville, Ind., Municipal Airport. Mid-Southern Air Terminals, Inc., Little Rock, Ark., has announced plans for the construction of a $300,000 airport in that city. It will include about 350 acres.

Oakland expects to have an expanded naval reserve air base at its municipal airport. Plans approved at Washington include construction of a 90x120 ft. hangar with 20 ft. lean-to, a dormitory, derricks and other equipment. A public hearing will be held July 26 at Terre Haute, Ind., on a $125,000 bond issue for the development of Dresser Field as a municipal airport. Interstate Airlines is reported to have announced the city will be eliminated as a mail stop unless improvements are made by August 15, this year.

Open Curtiss Louisville Depot

A two story $100,000 administration building will be built at the Indianapolis, Ind., Municipal Airport this summer, according to city officials. The $75,000 hangar and depot of the Curtiss Flying Service at Seneca Park, Louisville, Ky., has been opened. The hangar has more than 10,000 sq.ft. of floor space, administrative offices, classrooms, reception rooms, a completely equipped machine shop. It is built of concrete, brick, steel and glass and measure 127x143 ft. The contract for construction was let in April to the W. F. Russell Company.

Two new runways, each 60 ft. wide, have been installed at Grand Forks, N. D. airport. The city of Pembina, N. D., on the boundary between this country and Canada, has purchased a 160-acre flying field site and hopes to make it an airport of entry. The Commercial Club and the American Legion of Holdrege, Neb., recently formed a corporation to develop an 80-acre airport, to serve that community.

Two new 2,000x130 ft. runways costing $15,000, have been completed at the Lincoln, Neb., Municipal Airport, and lighting equipment costing $6,200 has been installed. A new hangar for the Arrow Aircraft & Motors Corporation is nearing completion at Lincoln, Neb. It is 100x100 ft. and cost $20,000.

A 300-acre tract has been bought at Bangor, Me., for New England Air Terminals, Inc., of Boston, to be developed as the Bangor airport. Moline, Ill., is assured a municipally owned airport following approval of plans for a two-mill tax to pay for the project.

A $243,000 improvement program has been started on the 325 acre Wold-Chamberlain Municipal Airport at Minneapolis, Minn., following approval of the plan by the City Council and the Board of Estimate and Taxation. Development work includes removal of concrete race track encircling most the field and seeding of the landing area at a cost of $165,000; construction of a concrete taxiway on the west side of the field, $30,000; installation of complete lighting equipment, $13,000; laying of water mains, $15,000; construction of a boundary fence, $13,000. The plans for the airport were drawn up by Theodore Wirth, superintendent and engineer of the Minneapolis Park Board.

Name Committee To Watch Fliers

ROOSEVELT FIELD (L.I.).—A vigilance committee has been appointed here to have general supervision of pilots and planes on this field. Any irregularities observed by the committee members will be reported to the field managers and disciplinary action will be taken. The committee includes A. C. Long, of Air Associates; Capt. Frederick Becker, of the Laird Company; R. W. Browne, of the Curtiss Flying Service, and Roger Wolfe Kahn.

Slater Air Bill Passed By Wisconsin's Senate

MADISON (WIS.)—The Slater aviation bill has passed the Senate and is now awaiting the Governor's signature. It is expected that Gov. Walter Kohler will sign the bill.

Briefly, the bill if signed, will fix the liability of airplane pilots and owners, will regulate stunt flying and provide penalties for violators; will allow legislative bodies to purchase, operate and provide regulations for airports, will order uniform marking systems for all airports and will require licensing of pilots, mechanics, aviation schools and fields in accordance with regulations of the Department of Commerce.

To Test Adams Pick-up in Ohio

WASHINGTON (D. C.) — Further service tests of the Adams Air-mail Pick-up device are to be conducted about August 10 at Youngstown, Ohio, under auspices of the Post Office Department. The test will be in connection with the regular operations of the Pittsburgh-Cleveland route operated by Clifford Ball, Inc.

Air Mail Rates Discussed in Capitol

WASHINGTON (D. C.) — Readjustment of rates to be paid the air mail contractors by the government, recently brought up in a conference between the Post Office Department and officials of the companies concerned, was emphasized again July 8 when President Hoover conferred with the Post Office heads relative to the effecting of economies in all three of the mail systems—air, railroad and marine.

Further information about the air mail rate situation was announced in connection with this conference. It was estimated by Assistant Postmaster General Glover that a rate readjustment probably would cut between $1,500,000 and $2,000,000 from the sum paid to the operators in the department's next fiscal year. The total of $7,433,166 was paid the contractors in 1928.

As has already been announced to the industry, rate readjustments are being studied and some action may be expected by late summer or early fall. And these readjustments in most cases will be downward. A study of the operations costs of the companies during the month of June will be used as the basis for the rate changes.

This survey of the company finances resulted from the original conference between the Post Office Department and the company officials some time ago. A standard accounting system was evolved for the use of each company so that the operations of each could be most efficiently measured. Each company had hitherto kept its books its own way. The system permits separation of mail carrying activities from every other performed by the company so that a true picture of the actual cost of mail carrying in every part of the country is expected to result.

Under the contract between the government and the companies a rate readjustment is compulsory at the close of the first four-year period. This period ends, for some companies, about October 1. It will be recalled that some contractors are receiving $3 a lb. for mail carried while others are receiving less than $1. Mr. Glover explained that this situation is sure to arouse Congressional comment and that attention to the problem now should forestall being forced to make the changes.

Baltimore Firm Buys Land

BALTIMORE (MD.)—Baltimore Air Terminals, Inc., a link in the chain of corporations forming the Curtiss Flying Service, Inc., has purchased 365 acres of land at the intersection of Greenspring Avenue and Smith Avenue in the Greenspring Valley. One tract of 215 acres cost $456,423.50. Work will be begun at once so as to have the field ready before fall. Details for hangars, depots, shops and other buildings have been approved and construction will be started as soon as grading for the runways is completed.

FOREIGN ACTIVITIES

French Air Head Seeks Larger Budget

PARIS (FRANCE)—An increase of about $1,800,000 in the budget for French civil aviation is being sought by the French Air Minister, M. Laurent-Eynac. Under this financing it is planned to develop lighted airways, a wireless telephony system, provide additional subsidy to some of the airlines and extend some of those already in operation. Subsidies would be granted also to various communities attempting to develop municipal airports.

The Marseilles-Tunis line would be operated six times a week in both directions, twice daily trips would be made between this city and London on six days of the week, a start would be made on the Indo-China line with the operation of the Rangoon-Vinh service. The Marseilles-Algiers route would be operated five days a week throughout the year and the Paris-Elizabethville section of the line to Madagascar would be inaugurated.

In an attempt to keep the air ministry in closer touch with aviation in various parts of the French territory, Regional Directorates will be established in this city, Marseilles, Bordeaux, and in Algiers. It is planned to install medical services at Villacoublay, Orly and Marignane and those at Le Bourget will be expanded.

Trans-Atlantic Flights Fail

PARIS (FRANCE)—Defeated by head winds, Capt. Dieudonne Costes and Maurice Bellonte landed at Villacoublay July 14 after a flight of more than 3,100 mi. out over the Atlantic in an attempt to make an east-west flight to the United States. The men were in the air about 28 hr. and turned back in the vicinity of the Azores. They were flying a Breguet powered with a Hispano-Suiza engine. The Polish fliers, who took off from Le Bourget 45 min. ahead of Costes in a similar attempt, were forced to land at Graciosa Island in the Azores. Their machine was wrecked and Major Idzikowski was fatally injured.

R.A.F. Holds Annual Display

HENDON (ENGLAND) — The eighth annual R.A.F. Display, in which about 200 military craft were put through a series of drills and skillfully executed maneuvers, was held here July 13 before a crowd estimated at about 150,000. This event has become one of the most outstanding in England's aeronautical calendar. Formation flying is one of the departments in which the R.A.F. takes particular pride.

Maybachs for New Dirigibles

FRIEDERICHSHAFEN (GERMANY) —Eight engines will be constructed by the Maybach works, it is reported here, for use in the dirigible ZRS-4, which is now under construction at the plant of Goodyear-Zeppelin Corporation, Akron, O. The engines will be the same as those used to power the Graf Zeppelin, it is said.

Build Amphibion Attachment for Moth

LONDON (ENGLAND)—Short Brothers has developed an amphibion gear for the Moth light plane. The arrangement includes a central float, on which the wheels are fitted, and a pair of wing tip floats. The floats in general are the usual Short Brothers type. A skid has been installed at the rear end of the main float for use on ground landings.

The ground landing device consists of an axle extending through the float and projecting a bit from each side. From the axle project vertical legs (which include rubber compression shock absorbers) and at the end of these legs are the wheels. The legs are raised and lowered by the pilot by means of a screw device which locks them in place when a ground landing is attempted.

It is said that the performance of the amphibion Moth has been very satisfactory. Maneuverability on the water is aided by the skid which is designed also as a water rudder.

Southern Cross Sets Record

LONDON (ENGLAND)—The record flight between Australia and England of fifteen and a half days, made by Bert Hinkler in February, 1928, in an Avro Avian, has been lowered to 12 days 21 hr. 15 min. by the Southern Cross, famous trans-Pacific plane. This machine, a Fokker powered with three Wright Whirlwinds, carried on this latest exploit Captain Kingsford-Smith and Capt. Charles T. P. Ulm, pilots; H. A. Littlefield, navigator, and T. H. McWilliam, radio operator. The possibility of a trans-Atlantic flight this season is being considered seriously by the airmen. Success in this undertaking and continuation across the United States to California would mean a 'round the world trip for the machine.

New French Pursuit Plane Built

PARIS (FRANCE) — The Moraine-Saulnier plant has developed a new pursuit plane known as Type 222. It is powered with a Jupitor 380 hp. engine of nine cylinders.

Japan on Verge Of New Era in Air

KOBE (JAPAN)—According to a report drawn up here by the United States Vice Consul, George J. Haering, Japan is on the verge of a new era in national civil aeronautics. Expansion of airlines through the Japan Air Transport (a semi-official company) and airport development, are included in the country's program. One of the chief obstacles is the lack of airmindedness among the public, according to Mr. Haering, the prevalent attitude being that flying is limited to stunt activities.

There are at present four civil air services operated by private concerns under government subsidy. There are eight newspapers operating twenty planes for speeding up news gathering, and in some cases delivery, services. And in addition to this flying there is a certain amount by private individuals and the professional test pilots.

The four airlines operated are: A tri-weekly passenger, parcel and mail service between Osaka and Tokio; a tri-weekly mail service between Tokio and Sendai; a tri-weekly passenger and mail service between Osaka and Fukuoka; and a passenger and mail service between Sakai and Oita. At present Japan has seventeen civil airports, two of which are in Chosen.

Thirteen manufacturers are considered capable of taking care of the ordinary demands for aircraft but the Japanese products are considered inferior to the latest types developed abroad. This applies particularly to aircraft engines. Imports of both planes and engines will continue. What aviation manufacturing industry exists is due chiefly to the requirements of the military department.

The big hope of Japanese civil aviation appears to lie in the Japan Air Transport Company, incorporated in Tokio, October 20, 1928, with an authorized capitalization of $4,600,000. It has a subsidy of $9,226,140 spread over eleven years and the government guarantees the stockholders a dividend of 8 per cent per annum. This company started active operation April 1, 1929. Its equipment includes 29 planes and 34 spare engines. It operates the Tokio-Osaka and Osaka-Fuknoka lines, aforementioned.

Test Junkers Diesel

BERLIN (GERMANY)—The Junkers Diesel type airplane engine was test flown at Dessau July 11 in a three-and-a-half-hour flight. Waldemar Roeder, pilot, reported that the engine worked entirely satisfactorily. Considerable experimenting with the Diesel type has been carried on by the Junkers works.

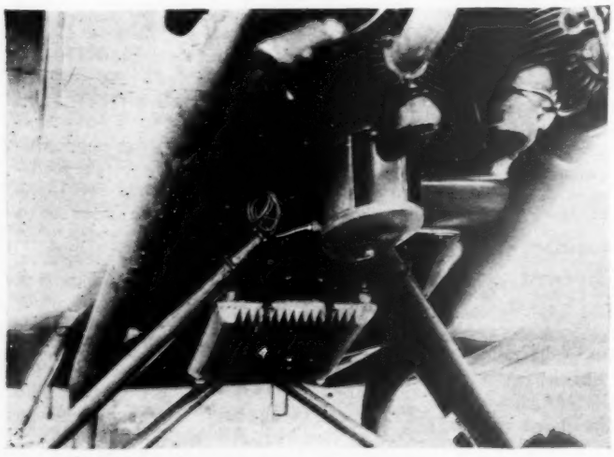
THE BUYER'S LOG BOOK

Buhl Air Heater

A NEW type of air heater for engines has been developed by the Buhl Aircraft Company, Marysville, Mich. The use of this device insures a quick warming up of the engine and, as it is during the warming up operation that most dirt is encountered, the device is so designed that all air must pass through the cleaner whether being drawn in through a stove or through the cold air opening.

The device consists of a streamline shell which bolts below the carburetor and within the shell is inclosed an air cleaner of the multiple screen type. The hot air is drawn through the stove on one of the exhaust pipes into the shell, thence through the cleaner and into the carburetor.

The cold air is admitted to the shell through a pair of doors in the front, these doors being controllable from the cockpit. When the doors are fully opened only cold air is admitted to the carburetor due to the fact that the incoming cold air enters under pressure due to the velocity of the plane while the hot air is drawn in over the stove due alone to the suction of the carburetor. When the doors are partially opened the cold and hot air



A photograph showing the installation of the Buhl Air Heater on a radial engine

mix in the shell, the exact temperature being indicated by a thermometer installed near the cleaner and within the shell. By means of but a single control this temperature may be maintained at any desired degree ranging from the normal air temperature to the full hot condition.

Allen Air Appliance Bulletin

BULLETIN No. A-50 describing in detail the "Triple-A" Centrifugal Air Compressor, has just been issued by the Allen Air Appliance Company, 462 Lexington Ave., New York, N. Y. Several other pneumatic devices are also described in this catalog which is available on request.

Bohnalite "X" Alloy

MANY uses will be found in both the airplane and engine branches of the aeronautic industry for Bohnalite X, a new light alloy which is 36 per cent lighter than aluminum and 78 per cent lighter than iron. This alloy is now being produced by the Bohn Aluminum & Brass Corporation of Detroit, Mich.

This new light alloy is being successfully used for castings, forgings and extrusion. Four grades of Bohnalite X are now available, and have physical properties as follows:

Bohnalite "X" No. 1: Sand cast—26,000 lb. per sq.in., t.s., 8 per cent elongation, 44 Brinell, 1.76 specific gravity.

Bohnalite "X" No. 2: Sand cast—2,300 lb. per sq.in., t.s., 1½-2 per cent elongation, 57 Brinell; after heat-treat—27-29,000 lb. t.s., 3-3½ per cent elongation, 63 Brinell, 1.84 specific gravity.

Bohnalite "X" No. 3: Sand cast—28,000 lb. per sq.in., t.s., 7 per cent elongation, 50 Brinell, 1.78 specific gravity; after heat-treat—31-32,000 lb. t.s., 8-9 per cent elongation, 56 Brinell.

Bohnalite "X" No. 4: Sand cast—21,000 lb. per sq.in., t.s., 2½ per cent elongation, 45 Brinell, 1.82 specific gravity; after heat-treat—25,000 lb. t.s., 6 per cent elongation, 40 Brinell.

Forged Bohnalite X will show tensile strength of 36,000 to 50,000 lb. per sq.in. with 12 to 18 per cent elongation, depending on the particular alloy used and its application.

The physical properties of Bohnalite "X" extruded shapes will vary from 38,000 lb. to 47,000 lb. per sq.in. with an elongation of 10 per cent to 16 per cent, depending on the particular alloy used.

Wrist Chart Board

IN ORDER to meet the demand for a device to stack, hold and roll charts and maps printed by the Government or by private concerns in a convenient manner, the "Wrist Chart Board" has been developed by J. A. Moler, 57 Lawton Street, New Rochelle, N. Y. This and several similar devices are now being distributed by aviation supply dealers throughout the country. Various models are supplied to strap to the wrist or knee and are provided with setting for Army strip charts and maps which cover the entire country in numerous routes. Several of these charts in rolls can be placed on the back of the chart board.

These charts can be easily pushed by hand from one end to the other of the board in a short time. Storage space is provided for several state maps which are made in book form, each map covering a 3,000 sq.mi. area can be placed on the chart board. This is also designed to hold the log book if necessary. The weight of this device is 14 oz.

These chart boards are also being installed in air liners for the convenience of passengers.

AVIATION

The Oldest American Aeronautical Magazine

July 20, 1929

AERONAUTICAL ENGINEERING SECTION

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An Analysis of Airplane Landing Speeds

By Elliott G. Reid
Stanford University

IT IS possible that there is not a very widespread realization of the absurdity of many of the published performance characteristics of our present commercial airplanes. It appears that the practice of exaggeration is very generally indulged in and there is presented herewith an analysis of airplane landing speeds as an illustrative example. It is not desired, however, to create the impression that the criticism is based upon this item alone; it was selected for convenience of demonstration. In lieu of detailed discussion, the statement of two cases which have recently come to the attention of the writer may indicate the territory which is included. To summarize these examples:

1. A description of a new airplane (not in the table published in Aviation) included the initial rate of climb with full load. Calculation demonstrated that the rate at which the weight of the machine would be elevated, in a vacuum, by the application of the rated power of the engine through a mechanism having a mechanical efficiency of 65 per cent (an optimistic estimate for climbing) was slightly less than the advertised rate of climb.

2. Two new airplanes, A and B, were announced by their manufacturers at about the same time. According to the published figures, B's top sped was about 10 m.p.h. greater than A's. With both now in service, it appears that the shoe is on the other foot and that A is about 10 m.p.h. faster. As the writer has been shown excellent reasons for accepting the performance tests of A, B's advertising doesn't look so good.

Let us now examine the landing speed situation in some detail. It is best illustrated graphically. Fig. 1 was prepared from the data given in the table "Manufacturers' Specifications on American Commercial Airplanes and Seaplanes as Compiled by Aviation," published in the issue of Aviation dated May 18, 1929. The coordinates of this chart are landing speed in miles per hour ("Performance with full load at sea level as supplied by manufacturers") and wing loading in lb. per sq.ft. ("normal gross weight loaded"/"wing area"). The points designated by single circles represent the airplanes listed in the table. In the cases of landing speeds stated as "*A* to *B* m.p.h.," the mean value $(A + B)/2$ has been used. The points identified by double circles are added for comparison; they represent the nine military airplanes used for the tests described in N.A.C.A. Technical Report No. 249, "Landing and Take-off Characteristics of a Number of Service Airplanes"—probably the most accurate study of the kind ever executed.

Any unbiased reader will admit that Fig. 1 resembles the familiar charts of "The Heavens in June." There appears to be some relationship among the points for the military airplanes but the whole chart is speckled with points representing commercial machines. While all our textbooks state that a large wing loading is invariably accompanied by a high landing speed, one has difficulty in correlating this rule with Fig. 1 in which, for example, airplanes with wing loadings ranging from 5.85 to 18.80 lb. per sq.ft. are seen to be credited with the same landing speed, 46 m.p.h.

Most textbooks, the older ones at least, also tell us that the landing speed of an airplane may be calculated by substitution of the maximum lift coefficient for the wings in the usual formula relating this coefficient with lift, wing area, speed and air density. It will be demonstrated below that this procedure is not justifiable and that an airplane lands at a speed corresponding to a lift coefficient smaller than the maximum. Common sense would dictate this conclusion since it is generally realized that the controllability of an airplane on the verge of stalling would be inadequate for landing. The values of the lift co-efficients at landing speed are, however, well worth some study. For the airplanes listed in the table, they have been computed in accordance with the equation

$$C_L = \frac{2W}{\rho S V^2} = \frac{W}{qS}$$

wherein

C_L = Absolute lift coefficient.
W = Weight of airplane (lb.).
ρ = Mass density of air (slugs/cu.ft.).
S = Wing area (sq.ft.).
V = Landing speed (ft./sec.).

$$q = \rho \frac{V^2}{2} = \text{dynamic pressure (lb. sq.ft.)}.$$

The results are plotted as the ordinates of Fig. 2, the abscissae being wing loadings. As in Fig. 1, double circles for the tested military airplanes have been added for comparison. The fact that the largest lift coefficient established by these carefully made experiments is only 1.31, constitutes a convincing proof that airplanes do not attain their maximum lift coefficients in landing. The absurdity of the majority of the landing speeds is now clearly apparent in the values of the lift coefficients. These lift coefficients not only exceed the nine experimentally determined values but also surpass the maximum lift coefficients of any unslotted wing; in fact some of them overshadow the highest values obtained by Handley Page and Lachmann in their experiments with multiply slotted wings.

The problem now confronting us is to establish a dividing line between fact and fiction. In view of the

excellent confirmation by British flight tests of model tests made in the N.A.C.A. variable density tunnel, it would seem fair to base the decision upon airfoil tests made in this tunnel. The maximum lift coefficients of several frequently used airfoils, as determined by tests at 20 atmospheres pressure, are listed below:

M—4	0.94	U.S.A. 35 A	1.21
M—6	1.22	U.S.A. 35 B	1.37
M—12	1.29	R.A.F. 15	1.21
U.S.A. 5	1.19	Gott. 387	1.33
U.S.A. 27	1.39	Clark Y	1.38

(Taken from N.A.C.A. Technical Note No. 219.)

These figures indicate it as very improbable that any wing of normal form will develop, at full scale Reynolds number, a lift coefficient greater than 1.4. This conclusion is also borne out by flight tests. The largest flight test C_L value of which I can find record is 1.46, and the method of test leaves some room for doubt of the accuracy. (A single exception is found in the case of the R.A.F. 19 airfoil. Variable density tunnel tests at full scale Reynolds number gave $C_{L\ max.}$ as 1.63 for the airfoil and 1.42 for an airplane model with wings of this section; the latter value has been confirmed in flight. No American airplane has wings as highly cambered as is the R.A.F. 19.)

Let us now consider Fig. 1 again. A curve of wing loading vs. landing speed for $C_L = 1.4$ appears there; parallel to it and displaced therefrom by increments of 5 m.p.h. are four curves which serve to indicate the minimum probable errors in the advertised landing speeds. It is believed that the errors are, in most cases, slightly larger than those indicated by the chart. Eighty-seven airplanes are listed in the table but four of these are not considered as the data are incomplete. Of the remaining eighty-three machines, seven are not open to

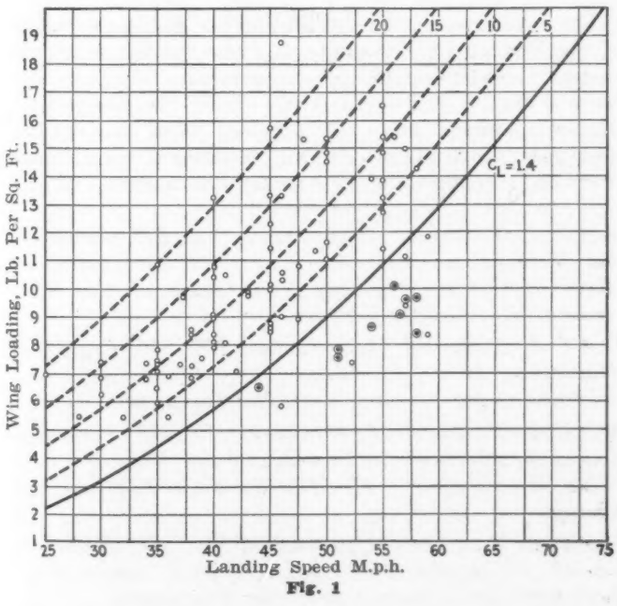

Fig. 1

criticism—i.e., the lift coefficients at landing speed are less than 1.4. Seventy-six airplanes are credited with suspiciously low landing speeds; nine of these appear to involve errors of less than 5 m.p.h., thirty-one lie between 5 and 10 m.p.h., twenty-six fall between 10 and 15 m.p.h. and in ten cases the error exceeds 15 m.p.h.

It is anticipated that explanations involving "high lift wings," "ground effect," "skillful piloting," etc., may be offered in defense of some of these figures. The salient features of these considerations can be treated rather briefly.

Differences between wing profiles are of no importance as regards landing speeds unless (as is very rarely the case) the angle of attack in the landing condition ap-

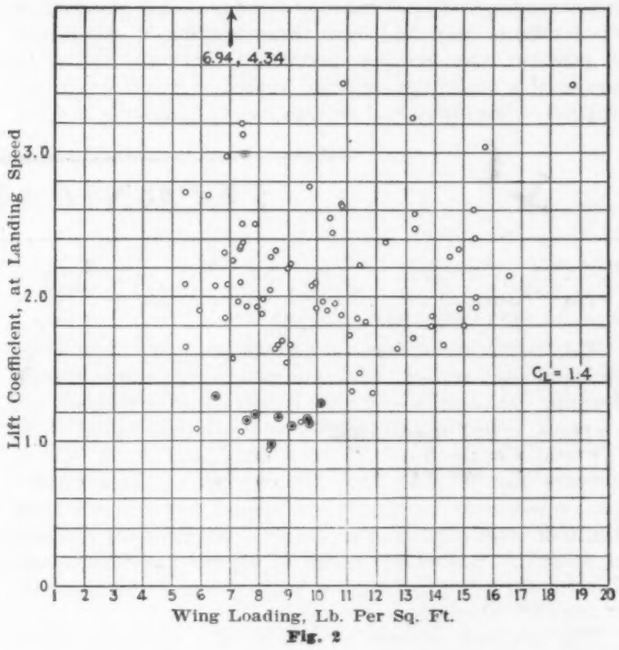

Fig. 2

proaches closely, or exceeds, that corresponding to maximum lift. In other words if, for the R.A.F. 15 wings of a conventional type of airplane, there be substituted a set having the same plan form and arrangement, but of Gottingen 387 profile, and the latter be so rigged that zero lift will occur with the fuselage in the same attitude with respect to the relative wind as in the original condition, then the landing speeds may be expected to be equal. It is assumed, of course, that the weight of the airplane remains unchanged. In only the exceptional, and rather improbable, case mentioned above would it be beneficial to substitute a wing having a large maximum lift coefficient for a profile having a smaller one.

There is nothing particularly mysterious about the effect of proximity to the ground upon wing characteristics. It is simply a reduction of the induced angle of attack with a corresponding increase of the slope of the lift curve. Unfortunately for the use of this influence as an explanation of the attainment of very high lift coefficients in landing, the lift curve slope does not increase indefinitely as the height/span ratio is reduced but, on the contrary, approaches a theoretical asymptotic value which is only a little greater than the slopes of the lift curves for high aspect ratio airfoils. Stated from another point of view, the greatest possible effect is complete elimination of the induced angle of attack which is a small part of the geometric angle of attack. At a given angle of attack, then, the greatest possible increase of the lift co-efficient obtainable by approaching the ground is relatively small.

While it is undoubtedly true that a skillful pilot can, under favorable conditions, land an airplane at a speed lower than its normal landing speed, this has no bearing on the case in hand. It is naturally assumed that the

advertised landing speed corresponds to a straightforward three-point landing and not a "pancake."

The underlying causes of the present state of utter confusion with respect to landing speeds are not readily seen. It appears probable, however, that the difficulty of obtaining reliable experimental information on the subject, without resorting to elaborate and expensive methods of testing, is one of the chief factors. Air-speed meter readings are not entirely reliable unless a swiveling Pitot tube is used and even then installation errors due to position may become importantly large. Pacing by means of a motor car or other vehicle is much less trustworthy. Simplicity and accuracy is undoubtedly needed.

In conclusion, it has been shown that a large proportion of the published landing speeds of American commercial airplanes is unnecessarily erroneous. It is the writer's belief that a similar, although possibly less aggravated, condition is to be found among the other principal performance characteristics. If aeronautic advertising is to be kept from degenerating into meaningless words and figures, the time for unified and drastic action is ripe. It is suggested that airplane manufacturers, as a group, take such action as will prove necessary to provide themselves with a source of authentic performance data such as is now available to engine builders in the results of the Department of Commerce Type Tests.

TECHNICAL REVIEWS

N.A.C.A. Technical Report No. 315, Aerodynamic Characteristics of Airfoils—VI, continuation of Reports Nos. 93, 124, 182, 244, and 286.

This collection of data on airfoils has been made from the published reports of a number of the leading aerodynamic laboratories of this country and Europe. (A previous collection of airfoil sections numbered 1 to 759 and Charts 1 to 20 may be found in N.A.C.A. Reports Nos. 93, 124, 182, 244 and 286.) The information which was originally expressed according to the different customs of the several laboratories is here presented in a uniform series of charts and tables suitable for the use of designing engineers and for purposes of general reference.

The absolute system of coefficients has been used, since it is thought by the National Advisory Committee for Aeronautics that this system is the one most suited for international use and yet it is one from which a desired transformation can be easily made. For this purpose a set of transformation constants is given.

Each airfoil section is given a reference number, and the test data are presented in the form of curves from which the coefficients can be read with sufficient accuracy for designing purposes. The dimensions of the profile of each section are given at various stations along the chord in per cent of the chord length, the latter also serving as the datum line.

The N.A.C.A. Technical Report No. 307, Pressure Distribution over the Horizontal and Vertical Tail Surfaces of the F6C-4 Pursuit Airplane in Violent Maneuvers, by R. V. Rhode.

This investigation of the pressure distribution on the tail surfaces of a pursuit airplane in violent maneuvers was conducted by the National Advisory Committee for Aeronautics at the request of the Navy Bureau of Aeronautics for the purpose of determining the maximum loads likely to be encountered on these surfaces in flight. The information is a part of that needed for a revision of existing loading specifications to bring these into closer agreement, with actual flight conditions. A standard F6C-4 airplane was used and the pressure distribution over the right horizontal and complete vertical tail surfaces was recorded throughout violent maneuvers. The results show that the existing loading specifications do not conform satisfactorily to the loadings existent in critical conditions, and in some cases were exceeded by the loads obtained.

An acceleration of 10.5 *g* was recorded in one maneuver in which the pilot suffered severely.

American Society for Testing Materials paper, Fatigue Resistance of Some Aluminum Alloys, by J. B. Johnson and T. T. Oberg.

This paper is presented as additional data on the endurance properties of aluminum alloys. Several investigators have presented such data, but a noticeable discrepancy exists in the results as reported. The endurance of fatigue limit has been assumed on the basis of about 300,000,000 cycles. The results reported in this paper indicate that 500,000,000 cycles are insufficient to determine the endurance limit. An endurance limit at 300,000,000 cycles is satisfactory for most practical purposes, but with modern aircraft equipment a propeller may be subjected to over one billion alternations of stress in a year's service.

S.A.E. Semi-Annual Meeting paper, Volatility Data on Natural Gasoline and Blended Fuels, by Oscar C. Bridgeman.

The extension of the equilibrium air distillation work of the Bureau of Standards to more volatile fuels requiring measurements at temperatures considerably below 0 deg. C. (32 deg. F.) has shown that the general relations deduced from the previous work are equally applicable to natural gasoline and to straight run aviation fuels and to natural gasoline motor fuel blends.

N.A.C.A. Technical Memorandum No. 515, Materials and Methods of Construction in Light Structures, by Adolf Rohrbach, from the Year Book of the Wissenschaftliche Gesellschaft fur Luftfahrt.

N.A.C.A. Technical Memorandum No. 516, Crankcase Scavenging of 2-Cycle Engines, by Hans List, from Zeithschrift des Vereines deutscher Ingenieure.

N.A.C.A. Technical Memorandum No. 517, Investigation of the effects of the Fuselage on the Wing of a Low Wing Monoplane, by H. Muttray, from Luftfahrtforschung.

N.A.C.A. Technical Memorandum No. 518, Investigation of Atomization of Carbureters, by J. Sauter, from Zeitschrift des Vereines deutscher Ingenieure.

N.A.C.A. Technical Memorandum No. 519, Force Measurements on Airplanes, by F. Seewald, from Zeitschrift fur Flugtechnik und Motorluftschiffahrt.

N.A.C.A. Technical Memorandum No. 520, Torsional Rigidity of Cantilever Wings, with Constant Spar and Rib Sections, by Giuseppe Gabrielli, from Luftfahrtforschung.

Analysis of the Wing and Other Indeterminate Structures

By JEAN FRADISS and ARMAND THIEBLOT
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PART II

IN THE first paper we have shown that the elementary methods based only upon the rules of statics are insufficient for solving most of the problems which are brought daily to the attention of the aeronautical engineer. Hence the need and importance of more exact methods.

Besides a rigorous investigation based on advanced methods of structural analysis, coordinated with exact aerodynamic data, by giving an accurate knowledge of the true margins of safety, is an important factor in the development of new designs and leads to a lighter and more efficient structure.

Statically indeterminate cases are so frequent in airplane design, that they seem to be, not the exception, but the rule. And these indeterminate systems can be solved only by the advanced methods based on the elastic properties of the structure.

The load factors imposed on airplane structures being comparatively small, it is very important that the engineer should know with exactitude the nature and distribution of the stresses.

The problems, as they are presented to the aeronautical engineer, are not only complicated because of the natural complexity of airplane structures, but also because of the lack of precision regarding the external forces.

For instance, it is just as hard to compute the stresses in a wing structure due to the torsional moment as to determine this moment with accuracy.

But we have seen that with the aid of the Focus of an airfoil section, and the Elastic Center of a wing section it is comparatively simple to solve such a problem.

The solutions based on the elastic properties of the structures are sometimes very easy, and sometimes very complicated. But in the latter case, it is often possible to find a particular solution that simplifies the problem—like the focus and the elastic center of a wing section permitting the computation of the true loads on the spars, the true torsional movement and the loads in the compression members of a wing section.

Nevertheless particular solutions of a general problem of solving for indeterminate structures are always based on the method of elasticity.

A Wing Structure Forms a System that is not Statically Determined.

There are three cases of static indetermination:

I.—*External:* the existence of too great a number of supports to determine the reactions by the rules of statics (for a multi-spar wing or a wing without spar the reactions on the fuselage structure are not statically determined).

II.—*Internal:* the presence of redundant member (such as compression member or wing covering).

III.—*Internal:* the shape of the body being such that an elementary distribution of the stresses is impossible (complex metal structures, wing covering etc.).

Therefore any kind of wing structure has several indeterminate elements.

Often the engineer makes an arbitrary simplification in order to transform the structure into a statically determined system—but practice shows that the error

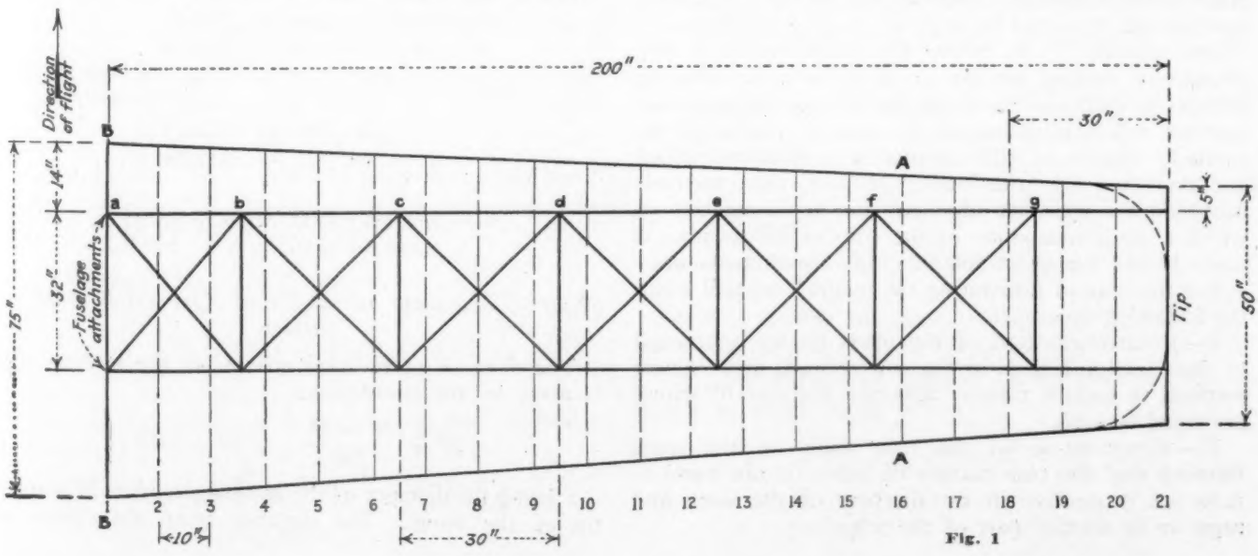


Fig. 1

involved is often of the same magnitude as the load in the members and therefore this simplification must be prohibited.

We will give several examples of practical solutions of wing structures considered as indeterminate system.

Example I: Analysis of a wing structure of the conventional type.

We will analyze a cantilever fabric covered wing built up of two wooden spars connected by a drag truss, as shown in Fig. I.

This structure is indeterminate because it is impossible to obtain by means of statics, regardless of the elastic properties of the structure:

I.—The true external loads on the spars.
II.—The true stresses in the spars.
III.—The loads in the compression members.

I.—The two spars, being connected by an inter-spar structure, that causes them to deflect together, are not independent of each other. According to the location of the center of pressure and to the relative inertia of the spars, one of them will have a tendency to deflect more than the other. This greater deflection however, will be partially or totally prevented by the compression members which will tend to equalize the deflections of both spars, thus adding to the torsional rigidity in preventing, to a certain extent, the wing section from altering its shape—since the load taken by each spar is proportional to its deflection, this load is not determined.

II.—The true stresses in each spar cannot be determined if the reactions of the drag members are not known—and generally there is too great a number of them.

The equations of equilibrium or any graphical distribution of the forces are insufficient to compute the true bending moments of the spars.

III.—The loads in the compression members are functions of the elasticity of the spars and therefore cannot be determined by means of statics alone.

The general method based upon the elasticity, in the case of a wing structure, often leads to very complicated calculations.

The following method based on the consideration of the elastic center is considerably shorter and easier. Only its degree of accuracy, though far above that given by the elementary conventional method, is slightly less than the degree of accuracy of the general method.

Our purpose is to show the insufficiency of the elementary method but not at all to deny its use, for instance to give an idea of the stress. In this particular case we will first determine the section moduli of the spars by means of the common approximate method and then find the true loads. In fact, most methods based on the elasticity are "cut and try" methods, in which a predetermination of the sizes of the member is made before the exact computations are carried out.

For the sake of illustrating the method, we will adopt the following program:

I.—Predetermination of the loads on the spars and of their section moduli by the conventional approximate method, in such a manner that the margins of safety are equal to zero.

II.—Computation of the true loads on the spars showing that the true margin of safety is not equal to zero but is positive in certain part of the wing and negative in another part of the wing.

III.—Determination of the loads in the compression members.

IV.—Calculation of the spars by the general precise method outlined above.

Predetermination of the loads on the spars and section moduli.

The analysis is made in accordance with the U. S. Department of Commerce Regulations.

We will assume the thickness ratio at the root to be equal to 20 per cent. and the thickness ratio at the tip to be equal to 10 per cent.

Useful Area:

$$\frac{75+50}{2} \times 200 = 12{,}500 \text{ sq.in.} = 86.8 \text{ sq.ft.}$$

Effective Area:

In determining the effective area and equivalent wing, sections 1, 4, 8, 13, 18 are considered. At section 16,

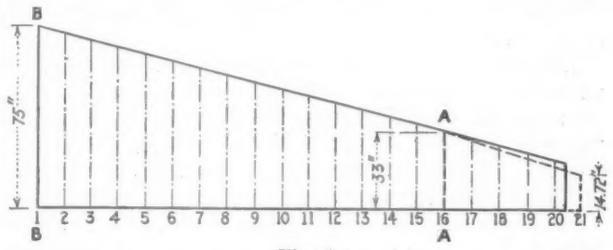


Fig. 2

the chord is approximately equal to the distance to the wing tip. The tip length is therefore assumed to be 50 in. (chord at the section 16) and the decrease of the semispan for tip loss is then 5 in.

The chord lengths of the equivalent wing at each of the above sections are calculated and listed below in Table I.

TABLE I

Sections	1	4	8	13	18
Distance from actual tip	200	170	130	80	30
Chord, C	75	71.25	66.25	60	53.75
Thickness of section	15	13.59	11.67	8.25	5.37
Section thickness, per cent	20	19	17.6	13.75	10
Thickness (20 per cent)	1	.95	.88	.687	.500
Chord of equivalent wing	75	67.6	58.3	41.22	26.8

Area of the equivalent wing: 9,293 sq.in. = 64.53 sq.ft. (See Fig. 2.)

Let us suppose:

Weight of the plane = 1,780 lb.
Weight of the wing = 320 lb.
Load factor = 7 (for the high angle of attack condition)
Total load = 10,220 lb.

$$\text{Total load on one wing } 10{,}220 = \frac{10{,}220}{2} = 5{,}110 \text{ lb.}$$

Load per sq.ft. = 79.18 lb./sq.ft.
Load per sq.in. = K = .549 lb.

Shear & Moments on the Front Spar High Angle of Attack

The distance of the rear spar from the leading edge is given by the expression:

$$37 + \frac{46-37}{200}\, x = 37 + .045\, x$$

x being the distance of the section considered from the tip of the wing. The distance from the center of

pressure located at 30 per cent of the chord the leading edge:

$$.30\ (50 + \frac{75 - 50}{200}\ x) = 15 + .0375\ x$$

The distance from the rear spar to the center of pressure:

$$37 + .045\ x - 15 - .0375\ x = 22 + .0075\ x$$

Shearing force on the front spar.

From tip to A we have (y being the ordinate of the trailing edge of the equivalent wing),

$$y = 14.72 + \frac{33 - 14.72}{50}\ x$$

$$y = 14.72 + .365\ x$$

The distance from rear spar to center of pressure

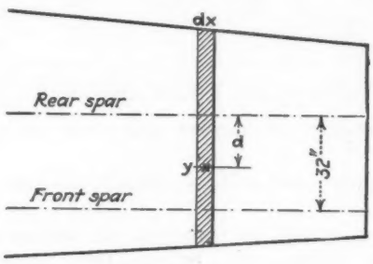


Fig. 3

being d, and k the unit loading.

Referirng to Fig. 3 we have:

$$y\ d\ x\ K\ \frac{d}{32}\ 32 = \text{Increment of load on front spar.}$$

Shear at A:

$$S_A = K \int_0^{50} y\ \frac{d}{32}\ dx$$

Where $K = .549$ lb. per sq.in.
and since $d = 22 + .0075\ x$

$$S_A = K \int_0^{50} (14.72 + .365\ x)\ \frac{22 + .0075\ x}{32}\ dx$$

$$S_A = \left[.0000468\ \frac{x^3}{3} + .139\ \frac{x^2}{2} + 5.55\ x \right]_0^{50}$$

$$S_A = 453.2 \text{ lb.}$$

Between A and B, the chord of the equivalent wing is:

$$y = 19 + \frac{75 - 33}{150}\ x = 19 + .280\ x$$

The shear at any point between A and B, is given by the following expression:

$$S = \int_{50}^{x} (19 + .280\ x)\ \frac{22 + .0075\ x}{32}\ K dx + S_A$$

$$S = .000036\ \frac{x^3}{3} + .108\ \frac{x^2}{2} + 7.16 + C$$

The constant C is determined by condition that when $x = 50$, $S = S_A$: $C = -41.29$.

$$S_B = \Big[.000036\ \frac{x^3}{3} + .108\ \frac{x^2}{2} + 7.16x - 41.29 + 453.2 \Big]_{50}^{200} + 453.2$$

$$S_B = 3646.7 \text{ lb.}$$

The bending moment is obtained as the integral of the shear.

$$M_A = \int_0^{50} (.0000468\ \frac{x^3}{3} + .139\ \frac{x^2}{2} + 5.55\ x)\ d\ x$$

$$= 9835 \text{ in. lb.}$$

Between A and B, the moment is:

$$M_B = \int_{50}^{200} (.000036\ \frac{x^3}{3} + .108\ \frac{x^2}{2} + 7.16\ x - 41.29)\ d\ x$$

$$M_B = 274588 + M_A$$

$$= 284423 \text{ in. lb.}$$

Shears & Moment on the Rear Spar
(Low Angle of Attack Condition)

Distance from Front Spar to leading edge:

$$5 + \frac{14 - 5}{200}\ x = 5 + .0450\ x$$

Distance from leading edge to center of pressure (at 50 per cent of chord):

$$.5\ (50 + \frac{75 - 50}{200}\ x) = 25 + .0625\ x$$

Distance from front spar to center of pressure:

$$25 + .0625\ x - (5 + .0450\ x) = 20 + .0175\ x$$

Load factor $= 4.55$
Load per sq. in. $K = .356$
Load on the rear spar.
The ordinate of the equivalent wing is:

$$y = (14.72 + 0.365x)$$

Shear at A:

$$S = \frac{K}{32} \int_0^{50} (14.72 + 0.365x)\ (20 + 0.0175x)\ dx$$

$$S = \int_0^{50} (0.00007\ x^2 + 0.0839x + 3.27)\ dx$$

$$S = 271.29 \text{ lb.}$$

Between A and B we have:

$$S_1 = \frac{K}{32} \int_{50}^{200} (19 + 0.280x)\ (20 + 0.0175x)\ dx$$

Total Shear $= S + S_1 = 2287.2$ lb.

The bending moment is obtained as the integral of the shear:

$$M_A = \int_0^{50} (0.00007\ \frac{x^3}{3} + 0.0839\ \frac{x^2}{2} + 3.27x)\ dx$$

$$M_A = 5872 \text{ in. lb.}$$

Between A and B the moment is given by the expression:

$$\int_{50}^{200} (0.000055\ \frac{x^3}{3} + 0.0659\ \frac{x^2}{2} + 4.23x + C)\ dx$$

C being determined so that for $x = 50$ the shear is equal to 271.29.

We have:

$$296 + C = 271.29$$

$$C = -25$$

$$M_B = \int_{50}^{200} (0.000055\ \frac{x^3}{3} + 0.0659\ \frac{x^2}{2} + 4.23x - 25)\ dx$$

$$M_B = 169359 \text{ in. lb.}$$

$$M_T = M_A + M_B = 175231 \text{ in. lb.}$$

Shear and Bending Moment on the front spar in low angle of attack condition.

$$S_A = \frac{K}{32} \int_0^{50} (14.72 + 0.365x)\ (12 - 0.0175x)\ dx$$

$$= 152.26 \text{ lb.}$$

$$S_B = \frac{K}{32}\int_{50}^{200}(19+0.280x)\ (12-0.0175x)\ dx$$
$$= 867 \text{ lb.}$$
$$S_T = 1{,}019 \text{ lb.}$$
$$M_A = \frac{K}{32}\int_{0}^{50}(-0.0064\frac{x^3}{3}+4.123\frac{x^2}{2}+176.6x)\ dx$$
$$= 3{,}367 \text{ in. lb.}$$
$$M_B = \frac{K}{32}\int_{50}^{200}(-0.0049\frac{x^3}{3}+3.03\frac{x^2}{2}+228x)\ dx$$

The constant of integration is determined so that
$M_A = 3{,}367$ in. lb.
$M_B = 82{,}272$ in. lb.
$M_T = 85{,}637$ in. lb.

Determination of Section Moduli of the Spars

The lighter spar is designed by the condition.

$$\frac{M}{I/y} = \text{(constant)}$$

But, in the case of a wooden spar with unequal flange depths, we have:

$$\frac{M}{(I/y)_u} = (F_{all.}) \text{ in compression} = C_u$$
$$\frac{M}{(I/y)_L} = (F_{all.}) \text{ in tension} = C_L$$

hence:

$$\frac{y_u}{y_L} = \frac{C_u}{C_L} \qquad (1)$$

and $$y_u + y_L = h \qquad (2)$$

Where h is the mean spar height.

$$y_u = \frac{hC_m}{C_u + C_L}$$

y_u and y_L are determined by equation (1) and (2).

We will assume $C_u = 5{,}500$ lb./sq.in. and $C_2 = 8{,}000$ lb./sq.in., so that, with a normal width, the thickness of the lower flange is not less than half the thickness of the upper flange.

Front Spar in High Angle of Attack Condition

The moments between the tip and A are obtained by the equation determined above:

$$M_1 = 0.0000468\frac{x^4}{12}+0.139\frac{x^3}{6}+5.55\frac{x^2}{2}$$

At any point between A and B the moment is given by the expression:

$$M_2 = 0.000036\frac{x^4}{12}+0.108\frac{x^3}{6}+7.16\frac{x^2}{2}-41.29\ x+C$$

When $x = 50$, $M_2 = M_A = 9{,}835$ in., lb. and hence $C = 681$

Front Spar—H. A. A.
Determination of the Moment of Inertia

Section	20	17	14	11	8	5	2
	10	40	70	100	130	160	190
h	4.5	6	7.5	9	10.5	12	13.5
y_u	1.84	2.45	3.06	3.67	4.28	4.89	5.5
M	298	5893	21666	50651	96217	161415	249445
$(I/y)_u$	.054	1.071	3.939	9.209	17.494	29.34	45.35
I	.099	2.62	12.05	33.76	74.86	143.47	249.43
Corrected I	5	8					

The moments of inertia of sections No. 20 and No. 17 are respectively increased to 5 in.^{4} and 8 in.^{4}.

The same calculation is made for the rear spar in the following table:

Rear Spar in Low Angle of Attack Condition

Section	20	17	14	11	8	5	2
x	10	40	70	100	130	160	190
h	2.75	3.78	4.88	6	7.25	8.5	1044
y_u	1.12	1.53	1.99	2.44	2.95	3.46	4.07
M	193.2	3631	13177	30551	58365	98568	153342
$(I/y)_u$	0.033	.66	2.395	5.55	10.161	17.92	27.88
I	.037	1	4.77	13.54	30	62	113
Corrected I:	2	3.2					

Computation of the True Loads on the Spars

We will consider both spars in the low angle of attack condition.

The computations will be based on the following theorem:

The deflection of a point G of the neutral axis of a straight beam with one end fixed and the other free, is equal, with the opposite sign, to the sum of the moments with respect to this point, of fictitious vertical up-loads, $\frac{M}{EI}\ dx$, (the absolute value of M being considered), acting at each element dx of the portion of the neutral axis between G and the fixed end.

Therefore, if the deflection due to the shearing forces is neglected, the formula giving the deflection of a point located at a distance α from the tip of the wing is:

$$\lambda = -\int_{a}^{l}\frac{M\ (x-a)}{EI}\ dx$$

Where e is the distance from the tip to the root (See Fig. 4). By differentiating the above formula twice,

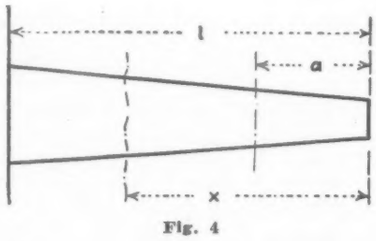


Fig. 4

with respect to x, we find the differential equation of the neutral axis:

$$\frac{d^2\lambda}{dx^2} = -\frac{M}{EI}$$

Since the moment of inertia is variable we will divide the spar into six sections and assume the moment of inertia to be constant and equal to the mean moment for each section. These sections are limited by the compression members.

In the first paper we have defined the "Elastic Center" as a point such that a load acting at this point causes equal deflections of the two spars.

This point is located at distances from the spars inversely proportional to their moments of inertia.

(Therefore, the distance from the rear spar to the elastic center is: $a = \frac{I_f}{I_f + I_r} D$, ($D$ being the distance between the spars).

If the total load were acting at the elastic center, the deflection of a point located at a distance a from the wing tip would be:

$$\lambda = \int_a^l \frac{(M_1 + M_2)\,(x - a)}{E\,(I_1 + I_2)}\,dx$$

Where M_1 is the moment of the front spar.
M_2 the moment of the rear spar.
The load in a compression member is proportional to

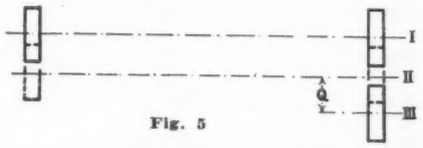


Fig. 5

the difference between deflection of the total wing and that of the spar alone.

The effect of the presence of the compression member is to nullify this difference of deflection Q (See Fig. 5).

For the rear spar at the first compression member, we have:

$$\lambda_R = \int_a^l \frac{M_2\,(x - a)}{EI_2}\,dx \qquad (1)$$

Where M_2 is the bending moment of the rear spar

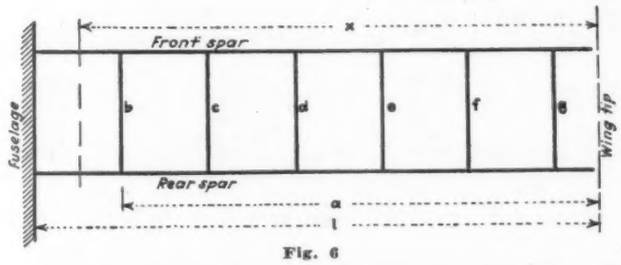


Fig. 6

at the first compression member and I_2 the mean moment of inertia between the wing root and the first compression member (see Fig. 6).

We have:

$$Q = \int_a^l \frac{(M_1 + M_2)\,(x - a)}{E\,(I_1 + I_2)}\,dx - \int_a^l \frac{M_2\,(x - a)}{EI_2}\,dx$$

or

$$Q = \int_a^l \frac{M_1\,(x - a)\,EI_2 - EI_1\,M_2\,(x - a)}{E^2\,I_2\,(I_1 + I_2)}\,dx$$

and

$$Q = \int_a^l \frac{(x - a)\left[\frac{M_1}{I_1} - \frac{M_2}{I_2}\right]}{E\,\frac{I_1 + I_2}{I_1}}\,dx$$

But, since the compression member nullifies the difference of deflections, we can write:

$$Q = 0 \qquad (2)$$

The reactions of a compression member on each spar are equal. Therefore, we have one unknown for each compression member. The moment at any point is a function of these unknown reactions, and we can solve the problem by writing equation (2) for each compression member. In the present case we have to solve the following system of six equations with six unknowns:

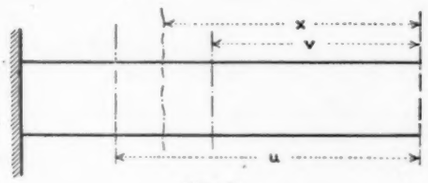


Fig. 7

$$\begin{cases} Q_b = \int_b^l \varphi_1\,(R_b)\,dx = 0 \\ Q_c = \int_c^l \varphi_2\,(R_c)\,dx = 0 \\ Q_d = \int_d^l \varphi_3\,(R_d)\,dx = 0 \\ Q_e = \int_e^l \varphi_4\,(R_e)\,dx = 0 \\ Q_f = \int_f^l \varphi_5\,(R_f)\,dx = 0 \\ Q_g = \int_g^l \varphi_6\,(R_g)\,dx = 0 \end{cases}$$

Where R_b, R_c, R_d, R_e R_f, R_g, are the unknown reactions of the compression members on the spars.

These reactions are assumed to be directed upward for the front spar and downward for the rear spar.

The bending moment of a spar between two compression members u and v, Fig. 7 is given by the expression:

$$M = \sum_{x=o}^{x=v} R\,d + (x - v) \sum_{x=o}^{x=v} R + M_1$$

Where $\sum_{x=o}^{x=v} R\,d$ is the moment of the reactions of the compression members about the compression member v.

$(x - u) \sum_{x=o}^{x=v} R$ is the moment of the sum of the reactions of the compression members, supposed to be acting at the compression member v, with respect to the compression member u,

M_1 is the moment due to the airload about the section considered.

Table I—Front Spar

First part of the Integral

X	$-.000054\frac{x^6}{72}\frac{1}{10^3}$	$.0336\frac{x^5}{30}\frac{1}{10^6}$	$2.53\frac{x^4}{8}\frac{1}{10^3}$	$-14\frac{x^3}{3}\frac{1}{10^3}$	Result
200....*a*	47999.5	358.51	506000	37224	
175....*b*	21541	183.79	296920	25009	
145....*c*	6966	71.904	139780	14226	
115....*d*	1735	22.512	5.5300	7095	
85....*e*	282.9	4.972	16520	2864	
55....*f*	20.74	.5634	2892	775.6	
25....*g*	.1836	010920	121.4	728	
a—*b*	—26.458	174.72	209080	12215	$344627\frac{1}{10^3}$
b—*c*	14575	111.88	157140	10783	$243662\frac{1}{10^3}$
c—*d*	5231	49.39	84480	713	$121508\frac{1}{10^3}$
d—*e*	1452	17.54	38780	4231	$50637\frac{1}{10^3}$
e—*f*	262.16	4.4	13620	2088	$15670\frac{1}{10^3}$
f—*g*	20.55	2770	702.8	25967	$25967\frac{1}{10^3}$

Table II—Front Spar

Second part of the Integral

X	$-.000054\frac{x^5}{60}\frac{1}{10^3}$	$0.336\frac{x^4}{24}\frac{1}{10^3}$	$2.53\frac{x^3}{6}\frac{1}{10^3}$	$-14\frac{x^2}{2}\frac{1}{10^3}$	S	Result = $\int X$
200....*a*	288.36	2237.7	3372.4	280		
175....*b*	147.69	1314.4	2259	214.36		
145....*c*	57.78	618.57	1285.4	147.16		
115....*d*	18.09	244.9	641.1	92.56		
85....*e*	3.99	72.9	258.8	50.56		
55....*f*	.452	12.8	70	21.16		
25....*g*	.00874	.547	6.57	4.36		
a—*b*	140.76	923.3	1113.4	65.64	1830.3	320250
b—*c*	89.91	695.9	974	67.2	1512.7	219341
c—*d*	39.69	373.6	644	54.6	923.3	106179
d—*e*	14.11	172	382.2	42	498	42330
e—*f*	3.53	60.1	188.8	29.4	215.9	11874
f—*g*	.443	12.25	63.4	16.80	58.4	1460

Table III

M	M_1		$\frac{M-M_1}{I}$
First Part of the Integral	Second Part of the Integral	Moment of Inertia	Value of the Constant Due to the External Load
344627	320250	249.6	97.5
243662	219341	143.4	170
121508	106179	74.86	205
50637	42330	33.76	247
15670	11874	12.	310
25967	1460	8	142

Table VI

M	M_1	I	$\frac{M-M_1}{I_1}$
First Part of the Integral	Second Part of the Integral	Moment of Inertia	Value of the Constant Due to the External Load
697113	646975	113	444
477724	430008	62	770
230683	201610	30	970
93170	77847	15.5	1050
28023	21154	4.77	1432
4477	2515	3.2	614

Table IV—Rear Spar

First part of the Integral

X	$.000055\frac{x^6}{72}\frac{1}{10^3}$	$.0659\frac{x^5}{30}\frac{1}{10^3}$	$4.23\frac{x^4}{8}\frac{1}{10^3}$	$-25\frac{x^3}{3}\frac{1}{10^3}$	Results
200....*a*	48804	703	846000	66650	
175....*b*	21939	360.4	496432	25405	
145....*c*	7095	141	233707	12670	
115....*d*	1767	44.15	92467	5115	
85....*e*	288	9.75	27600	1385	
55....*f*	21.12	1.105	4834	130	
25....*g*	.187	.0214	203	66650	
	48884	703	846000		
a—*b*	26935	342.6	349568	21990	697113
b—*c*	14854	219.4	262725	19255	477724
c—*d*	5328	96.85	141240	12735	230683
d—*e*	1479	34.4	64846	7555	93170
e—*f*	266	8.7	22787	3730	28023
f—*g*	20.9	1.08	4631	1255	4477

We have:

$$Q = \int_u^l (x-v)\left[\frac{M_f}{I_f} - \frac{M_r}{I_r}\right] = 0$$

or

$$Q = \int_u^b (x-v)\frac{M_f}{I_f} - \int_u^b (x-v)\frac{M_r}{I_r} = 0$$

Since we have assumed I to be constant between two compression members, we can write:

$$Q = \int_v^u (x-v)\frac{M_{vf}}{I_{vf}} + \int_u^t (x-u)\frac{M_{uf}}{I_{uf}} + \ldots$$
$$- \int_v^u (x-v)\frac{M_{vr}}{I_{vr}} + \int_u^t (x-u)\frac{M_{ur}}{I_{ur}} + \ldots$$

$$Q = \int_v^u (x-v)\left[\sum_{x=0}^{x=v} Rd + (x-v)\sum_{x=0}^{x=v} R + M_1\right] dx$$
$$+ \int_u^t (x-u)\left[\ldots\right] dx + \ldots$$
$$- \int_v^u (x-v)\left[-\sum_{x=0}^{x=v} Rd - (x-v)\sum_{x=0}^{x=v} R + M'_1\right] dx$$
$$- \int_u^t (x-u)\left[\ldots\right] dx - \ldots$$

The quantities ΣRd and ΣR have the opposite sign on the front spar and on the rear spar.

The values of the moment are given for each station for the front spar in Tables I and II. Table I gives the first part of the integral, that is $\int xMdx$ and table II gives the values of $\int_v^u Mvdx$. The coefficient of M, $\int_u^v (x-v)\,Mdx$, is given in Table III.

The same values are computed for the rear spar in Tables IV, V, and VI.

The coefficient of ΣRd is given by the expression:

$$\int_u^v (x-v)\,dx$$

For the first section we have:

$$\int_{175}^{200} (x-175)\,dx = 313\ \Sigma Rl_l$$

It is obvious that, the stations being equally spaced, this coefficient is constant and equal to:

$$\int_{145}^{175} (x-145) = 450$$

The coefficient of ΣR is given by the expression:

$$\int_u^v (x-v)^2 dx$$

For the first section we have:

$$\int_{175}^{200} (x-175)^2 dx = 4600$$

As for the coefficient of ΣRd, this coefficient is constant for the other sections and equal to:

$$\int_{145}^{175} (x-145)^2 dx = 9073$$

Table VII gives the values of the coefficients of ΣRd and ΣR divided by the moment of inertia. (The first line refers to the front spar and the second line to the rear spar.) The third line shows the difference or the result of equation (3) for each section.

In Table VIII expressions ΣRd and ΣR are determined. The first line lists the values of R_v drawn from ΣRd and the second line the same values drawn from ΣR.

The sum of these first two lines, which is given in the third line of the table, is the coefficient of R_v. And so forth for each section.

Therefore the coefficients of the first equation are given by the third line of Table VIII.

In order to determine the coefficients of the second equation the third line of Section 5 is added to the third line of Section 2. The third line of Section 8 is added to the third line of Section 5 to determine the coefficients of the third equation, etc.

Reactions of the compression members:

Substracting Equation (6) from the fifth we have:

$$3.96\ R_g = 470 \text{ lb.},\ R_g = 117 \text{ lb.}$$

and by successive elimination in the other equations:

$$R_f = 131 \text{ lb.}$$
$$R_e = 176 \text{ lb.}$$
$$R_d = 216 \text{ lb.}$$
$$R_c = 240 \text{ lb.}$$
$$R_b = 346 \text{ lb.}$$

The bending moment of the front spar and of the rear spar are respectively shown in Fig. 8 and Fig. 9. The plain lines show the moments calculated by means of the simplified common method and the dotted lines show the corrected moments.

It can be seen that the influence of the compression members in the distribution of the loads in the wing

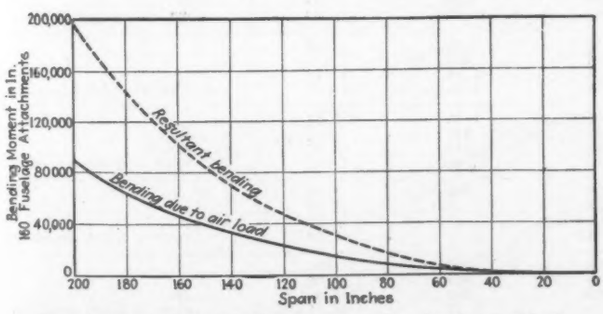


Fig. 8—Front spar bending moment, low angle of attack.

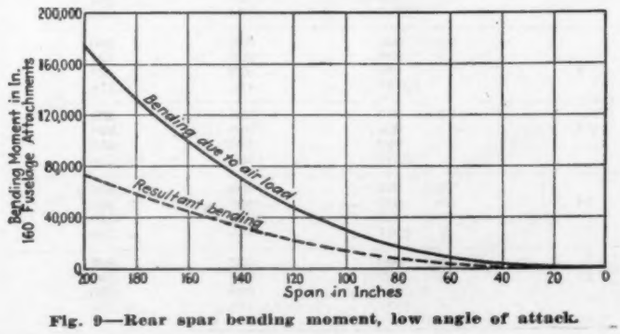


Fig. 9—Rear spar bending moment, low angle of attack.

structure is very important and should not be neglected if some accuracy is desired. Nevertheless this influence is particularly great in the above example because the moment of inertia of the rear spar is nearly half of that of the front spar. Besides the difference between the results given by the two methods would have been smaller if the deformation of the compression members and the moments at the points of attachments to the spars had been taken into account.

This was neglected because of the great difference of the moment of inertia of the spars and the compression members.

The above calculations show that, the rear spar for instance, though computed for a margin of safety equal to zero in low angle of attack, in fact has a positive margin of safety. But if similar calculations were carried out for the high angle of attack condition it is likely that the influence of the inter-spar structure would be of such a magnitude that the margin of safety of the rear spar for this condition would be negative.

The third of these articles will appear in an early issue.

Table V—Rear Spar

Second part of the Integral

X	$.000055 \frac{x^5}{60} \frac{1}{10^5}$	$.0659 \frac{x^4}{24} \frac{1}{10^3}$	$4.23 \frac{x^3}{6} \frac{1}{10^3}$	$-25 \frac{x^2}{2} \frac{1}{10^3}$	Results
200....*a*	293.7	4388.9	5638.5	500	
175....*b*	150.425	2578	3778	382.8	
145....*c*	58.85	1213.2	2149.2	262.8	
115....*d*	18.42	480.4	1071.8	165.3	
85....*e*	4.07	143	432.7	90.3	
55....*f*	.460	25.1	117.1	37.8	
25....*g*	.00891	1.07	10.99	7.8	
a—*b*	143.28	1810.9	1860	117.2	646975
b—*c*	91.57	1365	1629	120	430008
c—*d*	40.43	732.8	1077.4	97.5	201610
d—*e*	14.35	337.4	639.1	75	77847
e—*f*	3.61	117.9	315.6	52.5	21154
f—*g*	.45	24.03	106.11	30	2515

Table VII

Section	I	$\Sigma R l_1$	ΣR	Constant	
2	249.43	.00125	.0184	97.5	$\Sigma R l_1 = 30\,(Rc + 2Rd + 3Re + 4Rf + 5Rg)$
	113	.0027	.0407	—444	$\Sigma R = Rb + Rc + Rd + Re + Rf + Rg$
		+.00395	+.0591	—346	
5	143.4	.00313	.0632	170	$\Sigma R l_1 = 30\,(Rd + 2Re + 3Rf + 4Rg)$
	62	.00722	.146	—797	$\Sigma R = Rc + Rd + Re + Rf + Rg$
		+.01035	+.2092	—627	
8	74.86	.00601	.121	205	$\Sigma R l_1 = 30\,(Re + 2Rf + 3Rg)$
	30	.015	.302	—970	$\Sigma R = Rd + Re + Rf + Rg$
		+.021	+.421	—765	
11	33.76	.0133	.268	247	$\Sigma R l^2 = 30\,(Rf + 2Rg)$
	15.54	.0289	.583	—1050	$\Sigma R = Re + Rf + Rg$
		+.0422	+.851	—820	
14	12.05	.0374	.752	310	$\Sigma R l_1 = 30\,Rg$
	4.77	.0943	1.90	—1432	$\Sigma R = Rf + Rg$
		+.1317	+2.65	—1122	
17	8	.0562	1.13	142	$\Sigma R l_1 = 0$
	3.2	.140	2.83	—614	$\Sigma R = Rg$
		+1.962	+3.96	—470	

Table VIII

Section	R	R_c	R_d	R_e	R_f	R_g	Constant	
2	ΣRd .000	.1185	.237	.335	.474	.592		
	ΣR .0591	.0591	.0591	.591	.591	.591		
	.0591	.1776	.296	.414	.533	.651	—346	= 0 first equation
5	ΣRd .000	.000	.3105	.621	.931	1.242		
	ΣR .000	.209	.209	.209	.209	.209		
	.000	.209	.519	.830	1.74	1.451	—627	
	.0591	.386	.815	1.244	1.673	2.102	—97355	= 0 2nd equation
8	ΣRd .000	.000	.000	.630	1.26	1.89		
	ΣR .000	.000	.421	.421	.421	.421		
	.000	.000	.421	1.05	1.68	2.311	—765	
	.0591	.386	1.236	2.29	3.35	4.413	—1738.5	= 0 3rd equation
11	ΣRd .000	.000	.000	.000	1.26	2.52		
	ΣR .000	.000	.000	.851	.851	.851		
	.000	.000	.000	.851	2.11	3.37	—820	
	.0591	.386	1.236	3.14	5.46	7.783	—2558	= 0 4th equation
14	ΣRd .000	.000	.000	.000	.000	3.96		
	ΣR .000	.000	.000	.000	2.65	2.65		
	.000	.000	.000	.000	2.65	6.61	—1122	
	.0591	.386	1.236	3.14	8.11	14.39	—3680	= 0 5th equation
17	ΣRd .000	.000	.000	.000	.000	.000		
	ΣR .000	.000	.000	.000	.000	3.96		
	.000	.000	.000	.000	.000	3.96	—470	
	.0591	.386	1.236	3.14	8.11	18.35	—4150	= 0 6th equation

British Methods of Steel Aircraft Construction

By W. H. SAYERS
Boulton & Paul, Ltd.

AT THE present time seven or eight of the leading aircraft manufacturers of Great Britain regularly employ steel for the main structural members of wings in their military aircraft as against only two who have adopted duralumin for this purpose.

The first airplane with steel wings based on the use of corrugated strip for wing spars was the M.R.-1 produced by the Bristol Aeroplane Co. Ltd. (then known as The British and Colonial Aeroplane Co. Ltd.) in 1918. To this firm belongs the credit of having so early realized the possibilities of this type of construction. This machine was as a whole of Bristol design, but the detail design and construction of the wings was entrusted to the Steel Wing Co. Ltd., who may fairly claim to have been the earliest practitioners of this art.

As early as 1912 one J. J. Mayrow proposed and patented the use of thin strips of metal in corrugated form for the purpose of constructing airplane spars and other components, and a year or so later the construction of a machine embodying his scheme was attempted in England. Mr. Mayrow was not successful in his efforts but, in 1915, D. J. Mooney purchased the Mayrow patents, and formed the organization afterward known as the Steel Wing Co. Ltd., which has recently been absorbed by the Gloster Aircraft Co. Ltd. of Cheltenham. To this organization a large share in the credit for the progress of the technique of steel construction must be credited.

Other pioneers of this art are Armstrong Whitworth Aircraft Ltd. of Coventry, and Boulton and Paul Ltd. of Norwich, both of whom have been engaged on this class of construction for ten years. For some six or seven years the Bristol Aeroplane Co. Ltd. has also applied its energies to the development of steel strip contruction, and for a shorter period, The H. G. Hawker Co. Ltd. of Kingston-on-Thames has taken an active part in the same work.

This list is not to be taken as exhaustive. Others have played a part, but it is believed that it is fair to ascribe to these firms the bulk of the technical progress made up to date.

Thus a description of the methods peculiar to these firms will suffice to give a fairly complete account of the practical applications of the principles which were outlined in the earlier article of this series.

The Steel Wing Co. (Gloster Aircraft Co. Ltd.)

As the first firm to produce wings of the type now being discussed the work of this firm is of special interest from the historical point of view and it is therefore proposed to review in some detail the process of evolution through which steel wing-spars of their design have passed. The earliest spars by this firm were built-up girders of the type shown in Figs. 7 (a, b, c, d). These consisted originally of four trough-section booms connected both vertically and horizontally by some form of bracing strip.

At (a) the vertical bracing consists of two vertically corrugated strips which abut on, and are rivetted to, the two edges of each trough alternately. The horizontal bracing consists of two stamped strips forming a lattice stiffened at intervals by transverse struts. At (b) the four booms have been provided with beaded edges in order still further to stiffen them. This type of spar was not very efficient as a large amount of material was employed in the webs where it was ineffective to resist bending and end loads. At (c) is shown an improvement consisting of the formation of the web members in one with channels which form part of the flanges of the complete spar, while the webs have been lightened by stamp-

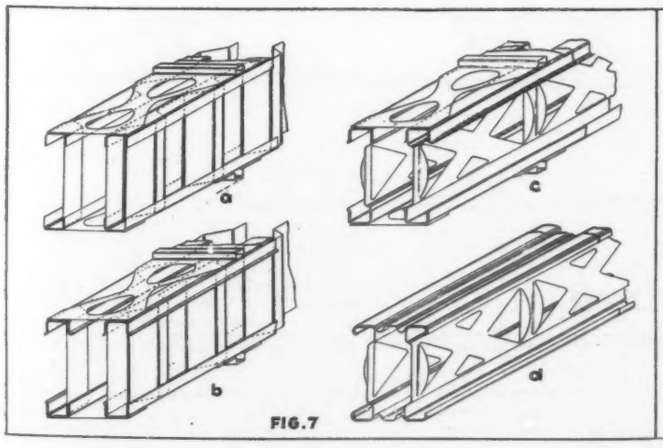


FIG.7

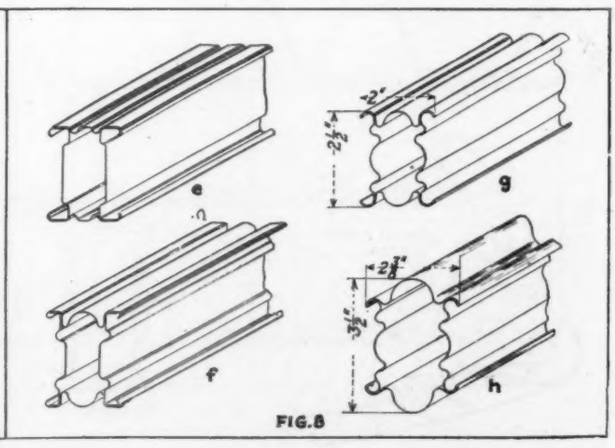


FIG.8

ing out to form a lattice shear bracing. The next stage (d) shows the combination of the web form of (c) with a single longitudinally corrugated flange strip. It is obvious that this form of flange, which can be rolled to form is a far simpler one to make than the earlier built-up forms, and it was found to be practically as effective as its predecessors in resisting lateral bending and better as regards resisting end loads.

From (d) Fig. 7 to (e) Fig. 8 the only change is the obvious one of omitting the stamping out of the webs, a great simplification from the production point of view. However the wide flat in these webs would inevitably fail from local instability, so the next stage (f), was the introduction of two extra corrugations in the webs accompanied by a deepening of the main corrugation in the flange. A further step as shown at (g) is the elimination of all flats from the webs, whereby the whole of the material in the section becomes effective in resisting end loads. The most serious defect of a spar such as this last is that the free edges of the strips are too close to

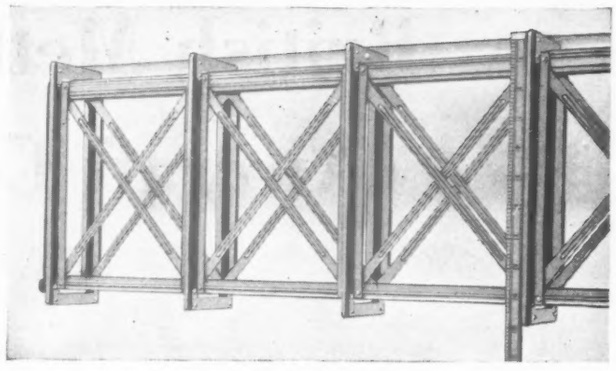


Fig. 10

the region of maximum stress intensity. This fault was remedied by raising the center of the flange above the edges as in (h). A spar of this type under a combination of bending and moderate end load will develop practically the full failing stress of which the material itself is capable. Under very heavy end loads such a spar may fail by longitudinal waving of the webs, particularly if the webs themselves are deep. Deepening the corrugations would tend to cure this were it not for the fact that if the tangents to the web at points where the curvature changes from concave to convex become horizontal the web becomes unduly weak in shear.

When such conditions are encountered some form of transverse stiffening must be provided. At (j) Fig. 9, is shown a spar so stiffened by two horizontal bulkheads. For still deeper spars an additional difficulty is introduced by the impossibility of obtaining strip steel of the required quality and uniformity above a limited width. This difficulty may be overcome by some such construction as shown at (k) where the webs are extended by trough sections which both support the flanges and act as horizontal stiffeners for the webs.

A characteristic of many of the airplanes built by the Gloster Aircraft Co. (who have recently absorbed the Steel Wing Co.) is the use of wings of unusually thick section, even on very high-speed machines, in which it is desirable to take full advantage of the torsional stiffness attainable by the use of a spar of the maximum possible

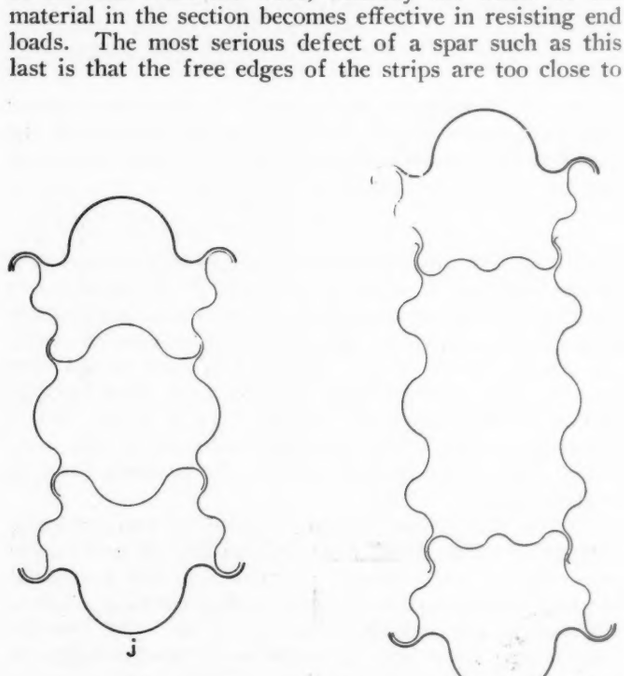


FIG. 9

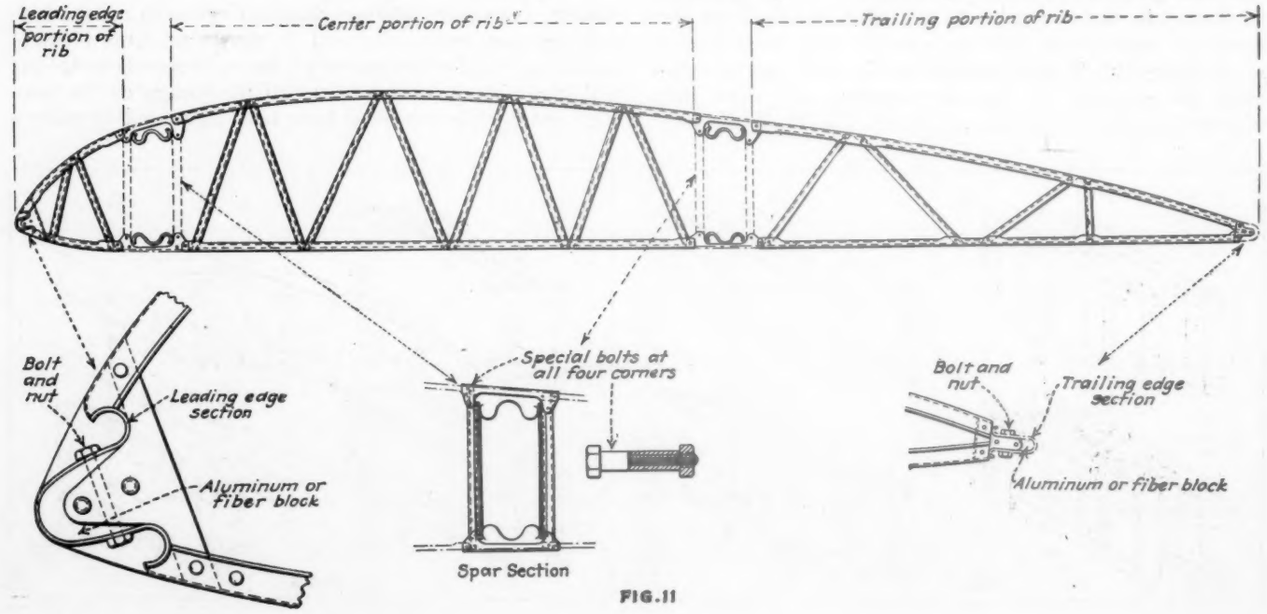


FIG. 11

depth. For use in such circumstances this firm has once more reverted to a built-up lattice girder type of spar. A specimen of this, 8½ in. deep, is shown in Fig. 10. It consists of two corrugated flanges, united by vertical posts of a double channel section with a lattice web formed of corrugated strips not unlike the familiar "Zeppelin" bracing strips. The vertical posts are arranged in pairs on each side of the flanges, and are tied together by top and bottom bridge pieces to form a series of boxes each entirely surrounding the flange and web system. These boxes serve for the attachment of the ribs, which are made in three separate sections and are bolted to the boxes as shown in Fig. 11.

This type of spar has obvious attractions and is probably the most satisfactory type to employ if it is necessary to provide a spar of the maximum possible stiffness in a wing of considerable depth of section. Where stiffness is not a primary consideration, however, it seems probable that the use of a box-type spar of less depth would provide the required strength for somewhat less weight.

Figs. 12 and 13 are interesting as showing two of the earliest successful attempts to produce all-steel wings. Fig. 12 is the wing of the Bristol "M.R.1," to which reference has already been made. Fig. 13 is a steel wing for the "Avro 504," a training machine used almost exclusively for the primary training of British military pilots from the middle of the War until the present day. Both these wings were designed and built by the Steel Wing Co. Ltd. in 1918.

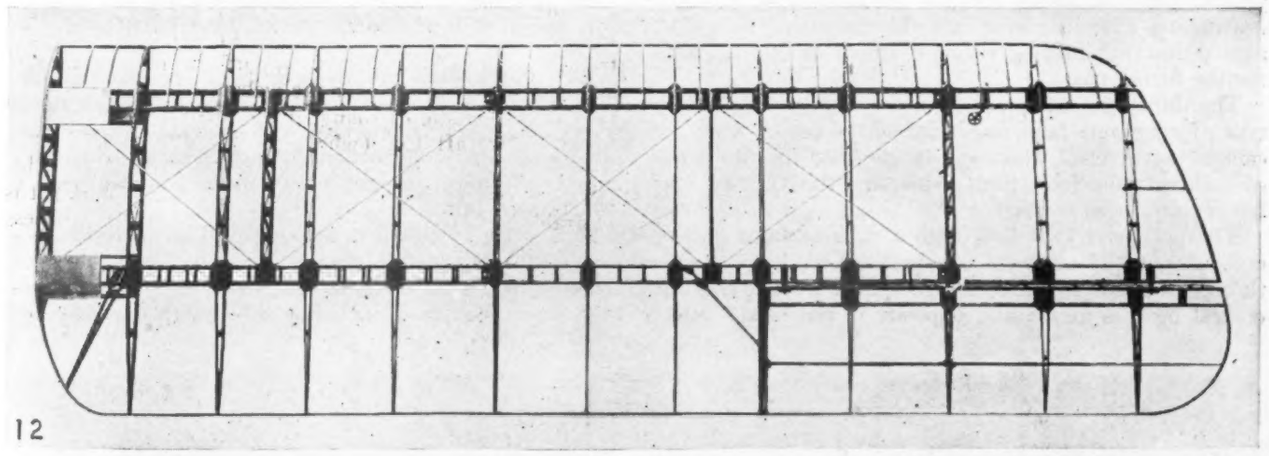
Fig. 14 shows the wing for a two seater "General Purposes" machine (the Westland "Wapiti") which is now being built in quantity for the Royal Air Force. These wings are made by the Gloster Aircraft Co. Ltd.

Fig. 15 shows a view in the works of the Gloster Aircraft Co., with a number of wings of this type in course of construction.

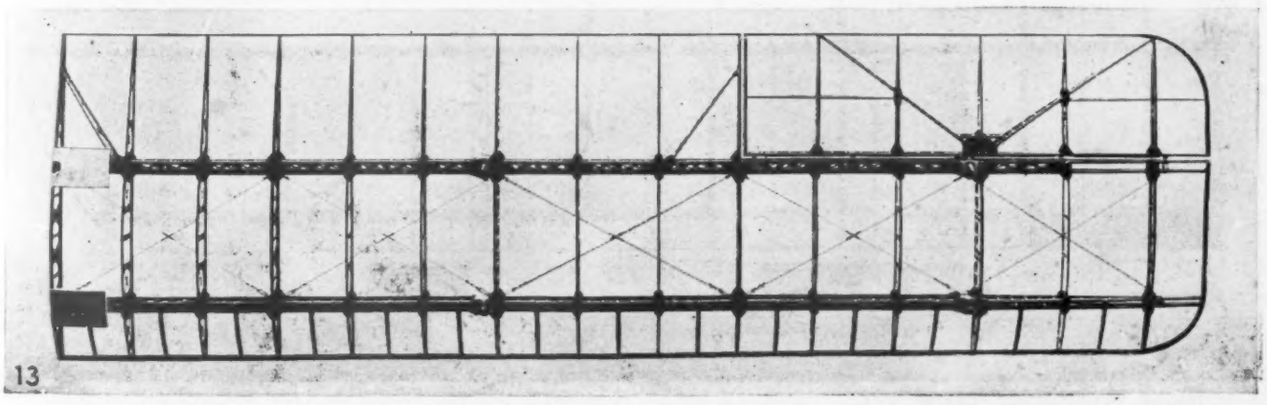
In the wings built by this firm, steel is used throughout the structure except for such items as packing blocks. The strip material is formed in the hardened and tempered condition and rolling is used as the chief method of forming.

Sir W. G. Armstrong Whitworth Aircraft Ltd.

Armstrong Whitworth Aircraft Ltd. was the first firm to produce an all steel airplane that was adopted by the Royal Air Force as a standard service type in considerable quantities. This particular machine was the "Siskin" single seat fighter which has now been in regular use for some six years with very satisfactory results. In order to discover whether the claims made for the corrugated strip type of construction, as a method which lent itself to rapid expansion of production in the event of war, were justified, the British Air Ministry some time ago placed orders for a number of these machines with each of several firms other than the designing firm. Armstrong Whitworth Aircraft supplied these firms with all the necessary drawings, together with technical information as to methods of manufacture, etc., but otherwise these firms were left to their own devices. The machines were produced without trouble and proved to be more nearly uniform in their qualities than was usually found to be the case with the wooden machines that were similarly built by firms other than the designers thereof during the War. The test showed that this particular claim was fully justified and has doubtless been one of the main factors leading to the decision that all future



12



13

service types for the Royal Air Force shall be of metal construction.

The earliest steel spars made by this firm were built-up of channel sections stiffened by corrugations, as shown in Fig. 16. This type was superseded by a type developed by Major H. N. Wylie who is the firm's technical authority on steel construction. One of these spars used on the first Siskin machine which was previously mentioned is shown in Fig. 17.

Owing to the difficulty of attaching fittings to this single webbed arrangement the production Siskins were provided with spars of the type shown in Fig. 18. Fig. 19 shows an end fitting for this type of spar, from which it will be seen that internal reinforcement by a

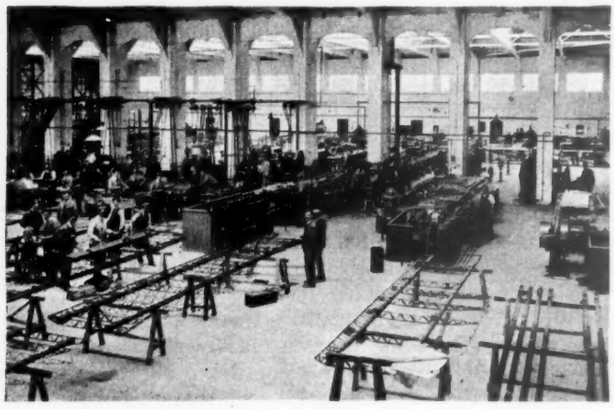


Fig. 15

special forging supplemented by external plates is employed. Fig. 20 shows a fitting for interplane and drag bracing on a similar spar, which employs a somewhat similar internal forging through which the fixing bolts for the fitting pass.

The difficulties of attaching fittings to the single web type of spar were later overcome by the use of what are called "pop rivets," which can be clenched into the walls of a closed tube from the outside, and this type of spar has recently been revived.

The pop rivet is hollow with a formed head on one end. A piece of rod with a conical end too large to pass through the hole is threaded through the rivet so that the conical head is at the end opposite to the head. Rivet and "nail," as the tool is called, are then pushed through the rivet hole, and the nail is withdrawn, causing the end of the rivet inside to expand and forcing the body of the rivet tight into the wall into which it is inserted. Figs. 20, 21, 22 show the modern single web type of spar in a variety of depths. It will be noticed that whereas in the earlier spars the sections used consisted of a series of curves of fairly large radius, the more recent types use a series of flats connected by angles or ridges. This formation, it is claimed, simplifies tool-making and permits of more accurate formation of the desired sections. Also it is said that the stiffening effect of the relatively sharp bends is greater than that of the larger radii and results in a stronger spar. The provision of flat faces also provides good landings for fittings that are to be rivetted on.

The tubular booms of the spars illustrated are built up from three segments provided with projecting lips over which are drawn capping strips of a bulbous form, rivetted through the lips. These strips provide ridges of great strength and give a concentration of metal where it is effective in giving the spar resistance to both lateral and vertical bending.

The corrugated webs used with this type of spar have proved surprisingly satisfactory. They owe their effectiveness in large part to the torsional rigidity of the tubular booms to which they are attached.

Fig. 23 shows another type of single-web spar in which the boom is drawn from a single strip instead of being built up from several strips. This type is used mainly for very light spars. This figure also shows how local reinforcement for the attachment of fittings is provided by liner tubes in the booms, fastened to pop rivets, and by side plates.

Fig. 24 shows an end fitting on one of the heavier type spars with a similar use of liner tubes and side plates.

Fig. 25 shows a tubular spar used for ailerons, etc. This is built up just as are the spar booms, from a series of segments, and is provided with internal stiffener diaphragms. This construction gives great torsional rigidity at a much lower weight than can be attained with a solid drawn tube.

Ribs made by this firm are of rolled strip section in a somewhat softer steel than is used for spars, and of thicknesses mostly 0.008 in. and 0.010 in. Various sections have been used, including tubes with inwardly lip-

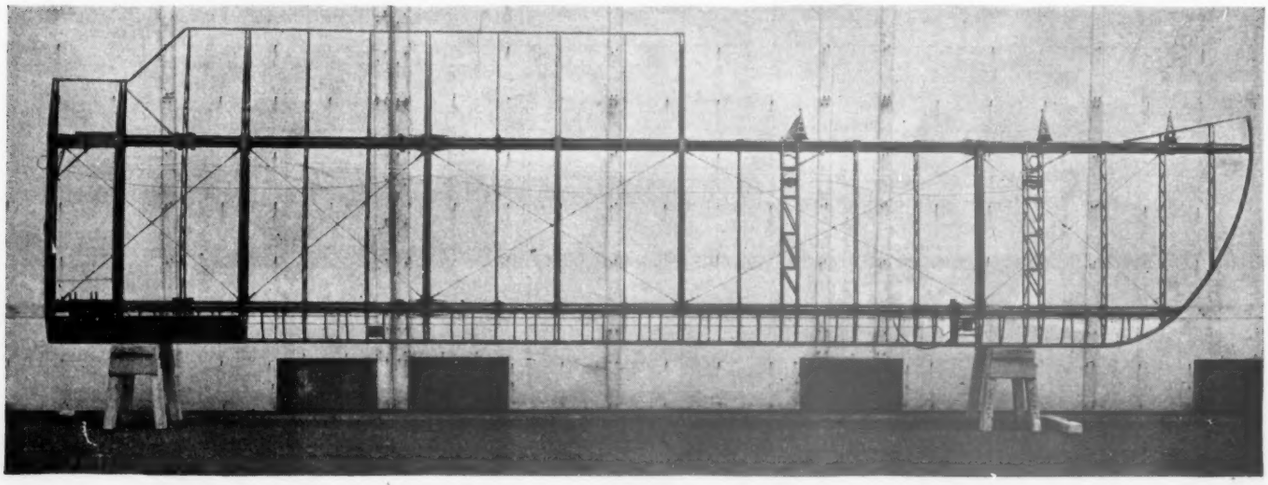
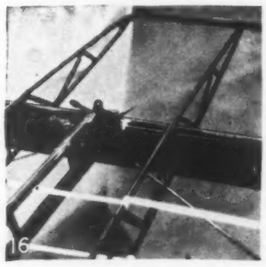


Fig. 14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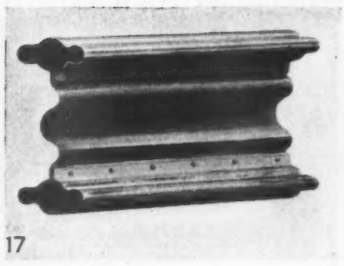
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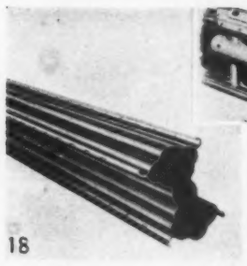
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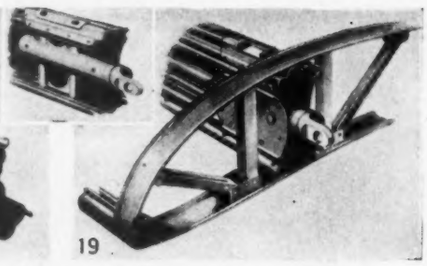
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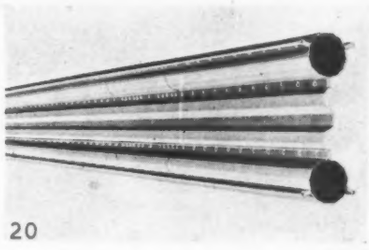
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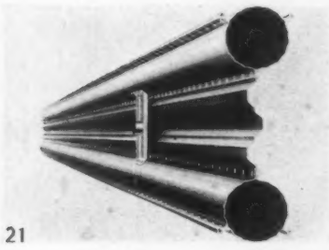
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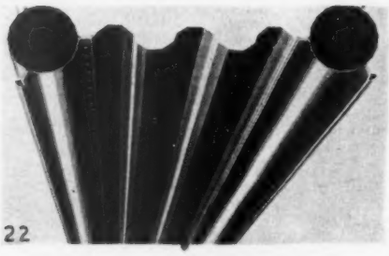
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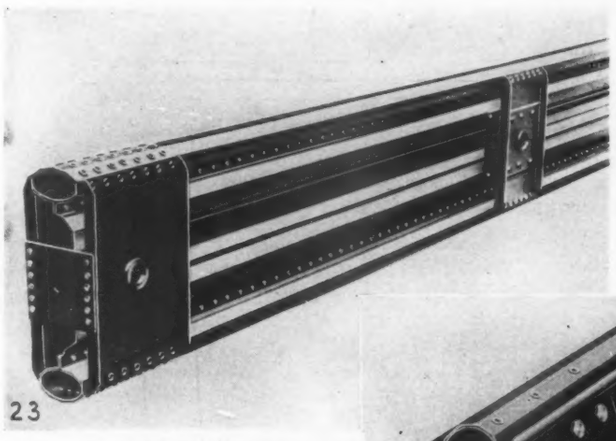
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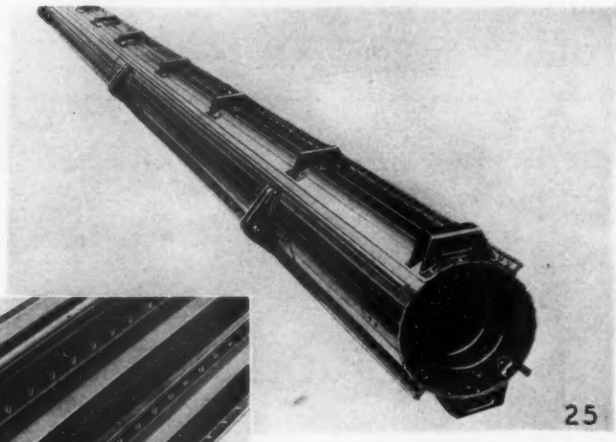
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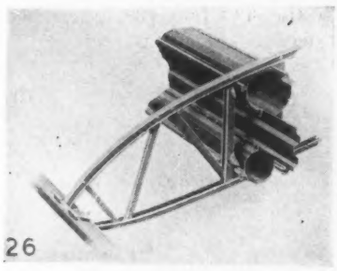
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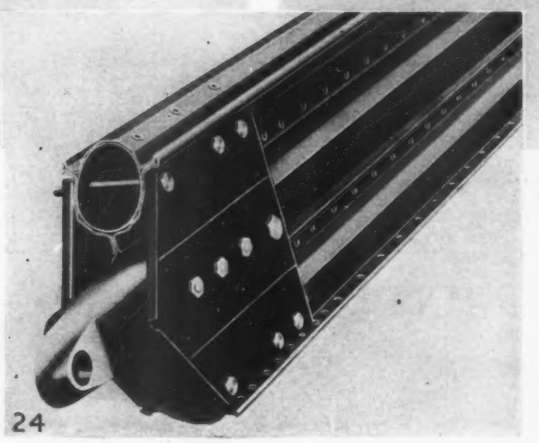
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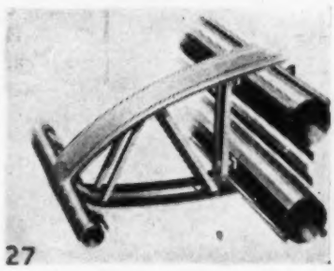
27

ped edges, square or rectangular tubes, and channel sections. In all such sections it is important that the edges should be stiffened by lipping or bending. Examples of such ribs are shown in Figs. 26 and 27, which also show the method of attaching the ribs to the spars.

A process known as "draw-rolling" is employed for the formation of many of the sections made by this firm. In this, forming takes place on a draw-bench but, instead of the usual fixed dies, rollers are used. It is much easier to produce straight members by drawing than by the usual rolling process, and this combined method combines this advantage with the reduced expenditure of power and higher speed of forming that is possible with normal rolling methods.

Spar and similar sections are formed from strip steel in the fully annealed condition and are thereafter hardened by a very ingenious process in which the formed strip is heated to the required temperature by passing through it a heavy electrical current. The strip is held under tension during the process which ensures straightness. The steel used is of the air-hardening type and thus no special quenching arrangement is necessary.

Fuselage frames are made from solid-drawn tubular members with machined fittings of a type such as those shown in Fig. 28. Although the more usual type of welded fuselage joint is now permitted by British regulations, this type of machine fitting is considered by many designers to have many advantages. In particular, classes of steel which cannot safely be welded can be used, and, although the machined fitting is more costly when made in comparatively small numbers, it is felt that in the event of production on a really large scale, the fact that fittings can be made on automatic or semi-automatic machinery and assembled by semi- or unskilled labor gives this type a distinct advantage over the welded joint. This advantage might become particularly important in

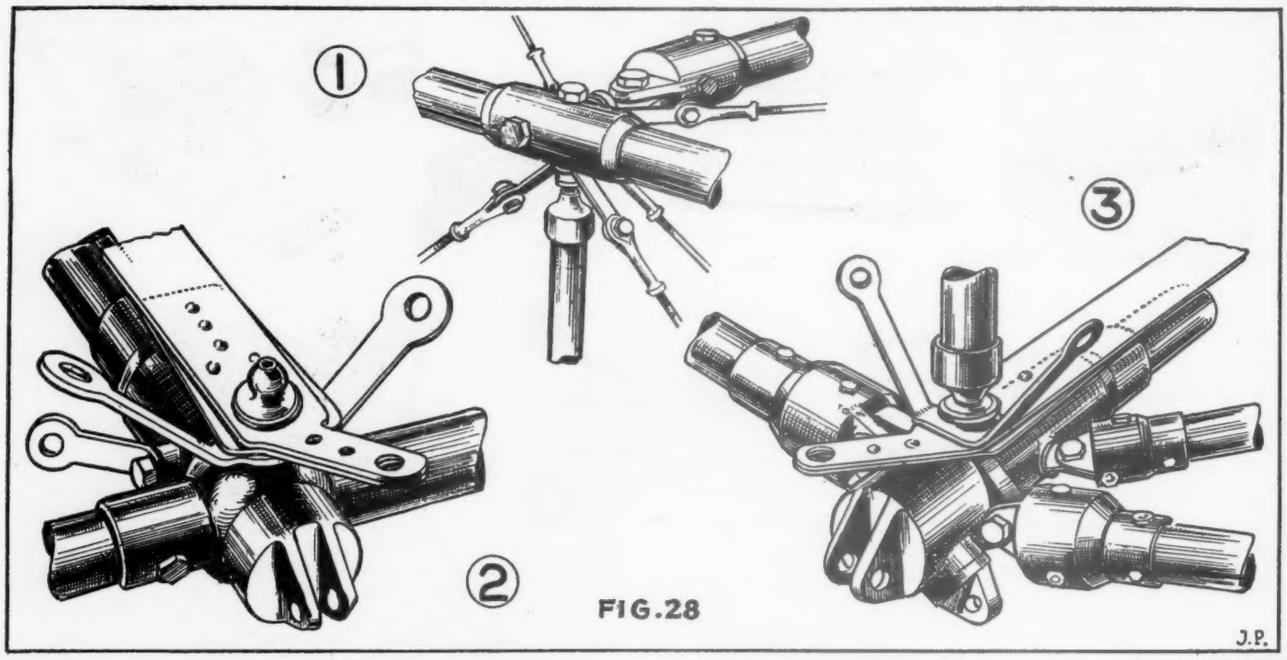

FIG. 28

Courtesy of FLIGHT

the event of a shortage of supplies of steel suitable for welding, which might occur in war time. It is, of course, true that the simplest of mild steel will be available whenever steel of any kind can be found, and that such material is particularly suitable for welding. But the advantages of being able to use material of higher quality are too great to be foregone merely because suitable steels for welding of such quality might be difficult to obtain.

All components of the complete steel framing are carefully cleaned by the use of scratch brushes to remove scale, and are thereafter stove enamelled. This has been found to afford satisfactory protection against corrosion under all service conditions. As this conclusion is based on the continuous use by the Royal Air Force of all steel machines of this make for some six years it can safely be assumed that, despite the apparent susceptibility of members of a thickness of a few thousandths of an inch to damage by rust, the steel machine of this type does not suffer in this respect under any conditions likely to be encountered in the normal way. It should be recorded that the all steel Armstrong Whitworth "Siskin" has been in service in Egypt, Iraq, and India, as well as in England and has proved satisfactory in all these climates.

[*The concluding article of this series will appear in the August 17 issue of* AVIATION]

PATENTS ISSUED

Patent No. 1,716,670—*Device for Launching and Landing Aeroplanes From and Upon Suspended Positions. Lawrence B. Sperry, Farmingdale, N. Y., assignor, by mesne assignments, to Lawrence Sperry Aircraft Co., Inc., Farmingdale, L. I., N. Y. Twenty-nine claims.*

Patent No. 1,718,956—*Aeroplane Landing Gear. Knut Henrichsen, Garden City, N. Y., assignor to Curtiss Aeroplane & Motor Co., Inc. Fourteen claims.*

Patent No. 1,719,797—*Airplane. Charles J. McCarthy, Flushing, and Michael Watter, New York, N. Y., assignors to Chance M. Vought, Great Neck, N. Y. Nine claims.*

Patent No. 1,719,798—*Aeroplane and Landing Chassis Therefor. Michael Watter, New York, N. Y., assignor to Chance M. Vought, Great Neck, N. Y. Eight claims.*

Patent No. 1,719,799—*Aircraft. Michael Watter, New York, N. Y., assignor to Chance M. Vought, Great Neck, N. Y. Thirteen claims.*

Design Patent No. 78,845—*Cabin Airplane Body or Similar Article. Lloyd Stearman, Wichita, Kansas. Term of patent* 14 *years.*

Patent No. 1,718,391—*Flying Machine. Lewis J. Tetlow, Holyoke, Mass. Eight claims.*

Patent No. 1,718,410—*Airplane Fuselage. Joseph L. Cato, Buffalo, N. Y., assignor to G. Elias & Bro., Inc., Buffalo, N. Y. Nineteen claims.*

Patent No. 1,718,577—*Aircraft Device. Harold F. Pitcairn, Bryn Athyn, Pa. Six claims.*

Patent No. 1,718,617—*Aeroplane. Charles J. Wagner, Cousins, New Mexico. Eleven claims.*

Patent No. 1,718,707—*Control Mechanism for Aeroplanes. Harvey M. Salisbury, Walnut Grove, and Arthur E. Miller, Sacramento, Calif. Six claims.*

Patent No. 1,718,834—*Airplane. Clarence O. Prest, Arlington, Calif. One claim.*

Patent No. 1,718,892—*Airplane. Frank Brown, Berkeley, Calif. Nine claims.*

Patent No. 1,719,293—*Airfoil. Paul E. H. Gripon.*

MANUFACTURERS' SPECIFICATIONS ON AMERICAN COMMERCIAL

THE TABLE BELOW IS BELIEVED TO BE ACCURATE BUT *AVIATION* DOES

This table will appear monthly and cor

MANUFACTURER	Designation	Price of Plane at Factory	Type	No. of Seats	Make of Engine	Total Rated HP.	Make of Propeller	Span	Wing Area (Sq.Ft.)	Length Overall	Height Overall	Weight Empty (Lb.) With Water If Water Cooled Engine is Used	Pay Load (Lb.)	DisposableLoad (Lb.)	Normal Gross Weight Loaded (Lb.)	Wing Loading (Lb. per Sq.Ft.)	Power Loading (Lb. per Hp.)	P Lev High Speed in M.P.H.	
Alexander Aircraft Corp.	Eaglerock A-1	.....	OBL	3	J 5	200	.....	36′ 8″	330	24′11″	9′11″	.....	.....	.....	2,491	7.54	12.45	130	...
Alexander Aircraft Corp.	Eaglerock A-2	2,250*	OBL	3	OX 5	90	.....	36′ 8″	330	24′11″	9′11″	.....	.....	.....	2,442	7.40	27.13	100	...
Alexander Aircraft Corp.	Eaglerock A-4	.....	OBL	3	E	180	.....	36′ 8″	330	24′11″	9′11″	.....	.....	.....	2,618	7.93	14.54	121	...
Alliance Aircraft Corp.	Argo	4,500	OBL	2	Wr	125	SS	28′ 8″	203	19′ 6″	9′	1,000	265	650	1,650	8.15	13.20	125	...
American Eagle Aircraft Co.	.....	2,985	OBL	3	OX 5	90	H, Hs	30′	300	24′ 6″	8′ 4″	1,227	840	830	2,057	6.85	22.85	101	...
Arrow Aircraft Corp.	Arrow-Sport	2,945	OBL	2	LB	60	.....	25′ 6″	178	19′ 2″	6′11″	524	.....	450	974	5.35	16.23	105	...
Bach Aircraft Co.	Air Yacht	31,800	CML	10–12	2 Sh 12-pww	650	2 Sty, SS	52′	412	36′ 1″	9′ 6″	3,300	.....	3,200	6,500	15.77	10.00	150	...
Bellanca Aircraft Corp.	CH-300	14,950	CML	6	J 6	300	M	46′ 4″	273	27′ 9″	8′ 6″	2,253	1,058	1,797	4,050	14.82	13.5	145	...
Bellanca Aircraft Corp.	CH-300 Seaplane	18,000	CMW	6	J 6	300	M	46′ 4″	273	30′ 5″	.....	2,833	1,033	1,772	4,605	17.00	15.35	130	...
Bird Wing Commer. Airplane Co.	No. 6	2,795	OBL	3	OX 5	90	Hs	31′ 4″	303	23′ 6″	8′ 7″	1,236	550	1,019	2,255	7.44	25.05	90	...
Boeing Airplane Co.	40-B	24,500	SBL	3	P Wh	525	H M	44′ 4″	545	33′ 4″	11′ 8″	3,543	1,436	2,536	6,079	11.15	15.19	132	...
Boeing Airplane Co.	40-C	22,500	SBL	5	P Ww	400	H M	44′ 4″	545	33′ 4″	11′ 8″	3,522	1,453	2,553	6,075	11.14	12.15	129	...
Boeing Airplane Co.	204	20,000	CBF	5	P Ww	400	H	39′ 8″	470	32′ 6″	12′	3,358	913	1,642	5,000	10.62	12.20	115	...
Boeing Airplane Co.	80-A	75,000	CBL	18+	3 Pwh	1,575	HM	80′	1,250	55′	15′ 2″	10,413	3,870	7,087	17,500	14.00	11.60	135	...
Boeing Airplane Co.	95	24,500	OBL	1	Pwh	525	HM	44′ 3″	490	31′11″	12′ 1″	3,196	1,600	2,644	5,840	11.90	11.10	140	...
Bourdon Aircraft Corp.	Kitty-Hawk	5,200	OBL	3	Y	105	W	28′	233	22′ 6″	8′6½″	1,142	360	808	1,950	8.36	18.57	110	
Breese Aircraft Co	.....	.....	CML	6	J 5	200	SS	41′	260	27	10′ 6″	155	.....	1,000	2,550	9.80	12.75	120	
Buhl Aircraft Co.	CA-6	13,500	CQL	6	J 6	300	SS	40′	305	.....	.....	2,478	1,192	.....	4,500	14.70	15.00	140	
Cessna Aircraft Co.	3-120	5,750	CML	3	A	120	H, Hs.	40′ 6″	224	23′ 8″	7′ 4″	1,250	480	750	2,000	8.92	16.66	125	
Cessna Aircraft Co.	4-125	4,075*	CML	4	Y	125	H, Hs	40′ 6″	224	23′ 8″	7′ 4″	1,260	760	1,030	2,280	10.17	18.24	125	
Cessna Aircraft Co.	4-200	9,800	CML	4	J 5	200	H, Hs	40′ 6″	224	23′ 8″	7′ 4″	1,350	800	1,070	2,420	10.80	12.10	150	
Command Aire Inc.	Comm'd-Aire	2,450*	OBL	3	OX 5	90	H	31′ 6″	300	24′ 6″	8′	1,275	375	800	2,075	6.91	23.05	104	
Cunningham-Hall Aircraft Corp.	PT-6	.....	CBL	6	J 6	300	SS	41′ 8″	370	29′ 8″	9′11″	2,475	1,000	1,725	4,200	11.30	13.10	140	
Curtiss-Robertson A'p'le Mfg. Co.	Robin OX-5	4,000	CML	3	OX 5	90	Hs	41′	243	25′ 9″	7′10″	1,489	328	728	2,217	8.94	24.14	101	
Curtiss-Robertson A'p'le Mfg. Co.	R-600	7,500	CML	3	R 600	170	CR	41′	243	25′ 1″	8′	1,700	454	962	2,600	10.70	15.29	120	
Davis Aircraft Corp	V-3	2,965	OML	2	LB	60	Hs	30′ 6″	145	19′ 8″	7′	816	350	500	1,300	8.96	21 66	95	
Doyle Aero Corp.	O-2	2,995	OML	2	LB	60	.....	30′	165	19′	.....	780	.....	500	1,280	7.75	21.33	103	...
G. Elias & Bro. Inc.	Aircoupe	3,350	CML	2	A	80	Elias	28′1½″	192	21′	7′ 2″	870	518	564	1,334	6.94	16.67	96	
Fairchild Airplane Mfg. Corp.	Fairchild KR-21	4,485	OBL	2	K	90	.....	27′	193	22′ 1″	9′	950	.....	600	1,550	8.02	17.2	120	...
Fairchild Airplane Mfg. Corp.	Fairchild KR-31	2,240*	OBL	3	OX 5	90	.....	30′ 1″	296	23′ 9″	9′ 4″	1,200	.....	878	2,078	7.00	23.0	102	...
Fairchild Airplane Mfg. Corp.	KR-34-A	6,575	OBL	3	J 6	165	.....	30′	285	23′ 5″	9′ 3″	1,435	.....	965	2,406	8.40	14.5	130	...
Fairchild Airplane Mfg. Corp.	Fairchild 71	18,900	CML	7	PWw	400	SS	50′	332	32′10¼″	9′ 4″	3,000	.....	2,500	5,500	16.56	13.75	138	
Federal Aircraft Corp.	CM-1	17,500	CML	5	J 4 B	200	We	37′ 6″	262	29′ 3″	9′	2,080	630	1,395	3,475	13.26	17.37	125	
Fleet Aircraft, Inc.	Fleet Model 1	.....	OBL	2	W	110	.....	28′	195	20′ 9″	8′ 9″	976	.....	554	1,530	7.84	13.90	111	
Fokker Aircraft Corp.	Universal	15,000	CML	5–7	J 6	300	H, Hs	47′ 9″	300	33′	7′10″	2,300	1,030	1,700	4,000	11.73	13.33	126	
Fokker Aircraft Corp.	Super-Univ.	21.800	CML	6–8	P Ww	400	SS	50′ 7″	370	36′ 7″	8′11″	3,000	1,134	2,150	5,150	13.91	12.84	138	
Fokker Aircraft Corp.	Fokker F-10	67,500	CML	14	3 P Ww	1,200	SS	79 3″	850	50′	12′ 8″	7,820	2,482	5,320	13,100	15.41	10.91	140	
General Airplanes Corp.	Aristocrat	7,500	CML	3	W	110	SS	36′ 4″	194.5	25′ 2″	7′ 7″	1,248	365	862	2,100	10.84	19.18	110	
Hamilton Metalplane Co.	H-45	.....	CML	8	P Ww	400	H	54′ 5″	387	34′ 8″	9′ 4″	3,300	1,153	2,408	5,750	14.33	14.35	135	
Hamilton Metalplane Co.	H-47	.....	CML	8	P Wh	500	H	54′ 5″	387	34′ 8″	9′ 4″	3,450	1,045	2,300	5,750	14.85	11.50	140	
Heath Airplane Co.	Parasol	695	CML	...	H	23	own	23′	94	16′ 9″	5′11″	290	.....	225	515	5.47	22.39	70	
International Aircraft Corp.	F-17	2,950	OML	3	OX 5	90	H	35′	325	25′	9′ 6″	7,480	320	620	2,100	6.49	23.33	100	
International Aircraft Corp.	F-18	12,250	OBL	6	J 5	200	SS	37′	360	27′ 6″	10′ 6″	2,200	950	1,550	3,750	10.41	18.75	125	
Ireland Aircraft, Inc.	N-2-B	22,000	CBL	5	J 6	300	SS	40′	380	31′	11′ 6″	2,940	750	1,468	4,400	11.60	14.64	110	
Irwin Aircraft Co.	M-T-2	1,165	CBA	1	179	25	own	20′	105	13′ 6″	5′ 9″	275	100	300	575	5.47	23.60	90	
Keystone Aircraft Corp.	Patrician	90,000	OBL	20	3 Cy	1,575	SS	90′	1,000	63′	13′	8,505	3,880	2,615	15,000	15.00	9.52	151	
Keystone Aircraft Corp.	Pathfinder	.....	CML	12	3 J 5	600	.....	66′ 6″	1,150	46′	.....	6,536	1,900	4,481	10,841	9.42	18.06	112	...
E. M. Laird Airplane Co.	Commercial	.....	CBL	3	J 5	200	SS	34′	300	23′ 6″	9′ 3″	1,550	800	.....	.....	.....	.....	130	...
Lincoln Aircraft Co.	Lincoln-Page	.....	OBL	3	OX 5	90	.....	32′	300	.....	.....	1,200	450	1,000	2,200	7.33	24.44	100	...
Lockheed Aircraft Co.	Vega	.....	OBL	5–7	J 5	200	SS We	41′	275	27′ 5″	8′ 6″	1,650	1,000	1,550	3,200	11.64	16.00	135	
Lockheed Aircraft Co.	Air Exp.	.....	CML	5–7	P Ww	400	SS	41′	275	27′ 5″	8′ 6″	1,850	1,000	1,845	3,645	13.25	9.11	167	
Loening Aeronautical Engr. Corp.	Cabin Amphibian	27,900	CML	8	Cy	525	SS	46′ 8″	517	34′ 8½″	13′ 2″	3,950	1,100	1,950	5,900	11.41	11.23	130	
Mahoney-Ryan Aircraft Corp.	Ryan B-5	13,250	CBA	6	J 6	300	SS	42′ 4″	280	28′ 3″	9′10″	2,200	1,000	1,800	4,000	14.30	13.30	140	
Metal Aircraft Co.	G-2-W	21,000	CML	8	P Ww	410	SS	50′	365	32′ 6″	9′ 6″	2,950	1,455	2,640	5,600	15.34	13.65	135	
Metal Aircraft Co.	G-2-H	23,800	CML	8	Pwh	525	SS	50′	365	32′ 6″	9′ 6″	3,060	1,355	2,540	5,600	15.34	10.66	140	
Mono Aircraft Inc.	Monocoupe	2,675	CML	2	V	55	Hs	32′	158	19′ 6″	6′ 3″	834	.....	475	1,175	7.43	21.36	90	
Mohawk Aircraft Corp.	Pinto	2,775	CML	2	V	55	.....	30′ 6″	124	22′	6′ 3″	850	200	500	1,350	10.88	24.54	100	
New Standard Aircraft Corp.	D-24	6,000	OBL	5	E	180	H	45′	350	26′ 6″	10′ 2″	2,066	790	1,334	3,400	9.71	18.88	115	90
Paramount Aircraft Corp.	Cabinaire No. 110	7,200	CBL	4	W	110	SS	33′ 2″	333	24′	9′	1,352	660	944	2,296	7.40	20.80	103	
Paramount Aircraft Corp.	Cabinaire No. 165	7,500	CBL	4	J 6	165	SS	33′ 2″	333	24′	9′	1,465	710	1,054	2,519	8.10	15.2	120	
Pheasant Aircraft Co., Inc.	H-10	2,375	OBL	3	OX 5	90	Hs	32′ 6″	283	23′ 6″	9′	1,297	600	785	2,082	7.35	23.13	100	
Pitcairn Aviation, Inc.	Mailwing	10,000	OBL	1–3	J 5	200	SS	33′	252	22′10″	8′10″	1,612	600	770	2,512	9.96	12.56	136	
Pitcairn Aviation, Inc.	Super Mailwing	.....	OBL	1–2	J 5	200	SS	33′	252	22′10½″	9′ 3″	1,892	.....	1,158	3,050	12.10	13.80	144	...
Pitcairn Aviation, Inc.	Sport Mailwing	.....	OBL	3	J 5	200	SS	33′	252	22′10½″	9′ 3″	1,892	.....	1,158	3,050	12.10	13.80	144	...
Richmond Airways, Inc.	Sea Hawk	.....	OMF	5	C 6	160	.....	46′	317	28′	.....	1,700	.....	1,000	2,700	8.51	16.87	95	...
Sikorsky Mfg. Co.	S-37	.....	CBL	18	# P Wh	1,000	.....	100′	1,149	45′ 6″	16′ 3″	8,000	4,060	7,000	15,000	14.29	15.00	122	
Sikorsky Mfg. Co.	S-38 Amphibian	.....	CQA	10	# P Ww	800	SS, H	71′ 8″	720	40′ 3″	13′10″	6,000	2,210	4,000	10,000	13.88	12.50	125	
Simplex Aircraft Corp.	Red Arrow K-2-S	4,500	OML	2	K 5	90	W	34′ 4″	160	22′ 3″	7′ 1″	1,100	243	685	1,785	11.10	19.80	125	
Simplex Aircraft Corp.	W-2-S	5,500	OML	2	W	110	W	34′ 4″	160	22′ 3″	7′ 1″	1,100	243	685	1,785	11.10	16.20	125	
Stearman Aircraft Co.	Coach	.....	CBL	5	J 6	300	SS	35′	338	30′11″	10′ 1″	2,550	950	1,650	4,200	12.50	14.00	135	
Stearman Aircraft Co.	C-4-A	.....	OBL	3	J 6	300	SS	38′	306	26′ 5″	10′ 2″	2,215	610	1,285	3,500	11.40	11.60	148	
Stinson Aircraft Corp.	SM-ID	12,500	CML	6	J 5	200	H	45′10″	292	32′	8′ 6″	2,400	1,340	2,100	4,500	15.41	22.50	125	
Stinson Aircraft Corp.	Junior SM-2	6,950	CML	4	W	110	Wd	41′ 6″	236	26′ 3″	7′ 9″	1,510	593	990	2,500	10.59	22.72	110	
Spartan Aircraft Co.	C-3	5,250	OBL	3	Wal	135	.....	32′	293	22′11″	8′ 9″	1,300	448	850	2,150	7.33	15.92	115	
Stout Metal Airplane Co.	4-AT-E	42,000	CML	12	3 J 6	900	SS, H	74′	785	49′10″	12′ 8″	6,500	1,725	3,630	10,130	12.90	11.25	130	
Stout Metal Airplane Co.	5-AT-C	55,000	CML	14	3 Pww	1,275	SS, H	77′10″	835	49′10″	13′ 8″	7,500	3,775	6,000	13,500	16.16	10.6	133	
Swallow Airplane Mfg. Co.	Commercial	.....	OBL	3	OX 5	90	.....	32′	300	24′	8′ 6″	1,470	360	730	2,200	7.33	24.44	100	...
Szekely Aircraft & Engine Co.	Flying Dutchman	2,000	OML	1	Sz	40	F	26′	108	18′	6′ 6″	551.5	231.5	.....	800	7.20	20.00	90	
Taylor Bros. Aircraft Co.	Chummy	3,800	SML	2	K 5	100	.....	34′	175	22′	7′ 6″	950	160	550	1,500	18.57	15.00	110	
Texas Aero Corp.	Temple	.....	OML	...	J 5	200	.....	39′ 4″	225	25′10″	8′ 3″	.....	567	.....	2,250	10.00	11.25	.....	...
Travel Air Mfg. Co.	B-4000	8,100	...	3	J 5	200	SS	33′	289	23′ 7″	9′ 1″	1,885	400	1,015	2,900	0.00	14.50	125	
Travel Air Mfg. Co.	D-4000	6,275	OBL	3	Ch	170	W, H, Hs	34′ 8″	296	24′ 6″	8′11″	1,600	385	1,000	2,600	8.80	15.30	126	
Travel Air Mfg. Co.	W-4000	5,575	OBL	3	W	110	W, H, Hs	34′ 8″	296	24′11″	8′11″	1,350	350	950	2,300	17.80	21.00	105	
Travel Air Mfg. Co.	6000-B	13,000	CML	6	J 6	300	SS	48′6½″	280	31′ 2″	9′ 3″	2,550	975	1,680	4,230	15.80	14.10	130	
Travel Air Mfg. Co.	A-6000-A	18,000	CML	6	Pww	420	SS	54′ 5″	340	31′ 2″	9′ 1″	3,250	975	2,000	5,250	6.20	13.10	138	
Waco Aircraft Co.	Waco "90"	2,145	OBL	3	OX-5	90	Hs	30′ 8″	286	23′ 6″	9′	1,199	.....	800	2,015	7.08	22.50	96	
Waco Aircraft Co.	Waco "165"	6,370	OBL	3	J 6	165	H, Hs	30′ 8″	286	23′	9′	1,529	.....	1,071	2,600	9.10	15.15	120	
Waco Aircraft Co.	Waco "220" Str. w	7,335	OBL	3	J 5	220	H, Hs	30′ 8″	286	22′ 6″	9′2½″	1,550	.....	1,050	2,600	9.10	11.80	125	
Waco Aircraft Co.	Waco "220" tap. w	8,525	OBL	3	J 5	220	M	30′ 3″	227	22′ 6″	9′	1,787	.....	823	2,600	1.45	11.80	135	
Waldron Aircraft Mfg. Co.	Starling	2,975	OBL	3	OX 5	90	H, Hs	32′	310	23′	9′	1,237	.....	600	1,837	.....	20.41	104	
Wallace Aircraft Co.	Touroplane "B"	4,885	CML	3	K	100	Hs	37′	212	23′10½″	8′	1,320	388	780	2,100	9.90	21.00	115	
Whites Aircraft	Hum. Bird	2,150	OBL	3	OX 5	90	Hs	33′ 1″	318	23′ 6″	8′ 3″	1,050	450	850	1,900	5.94	21.11	97	
Whittelsey Manufacturing Co.	Avian	4,995	OBL	2	Cir	95	W	28′	254	24′	8′ 6″	910	.....	690	1,600	6.30	16.70	102	

TYPE

A —Amphibian
B —Biplane
C —Closed
F —Flying boat
L —Landplane
M —Monoplane
O —Open
Q —Sesquiplane
S —Semi-closed
W —Seaplane

ENGINE: One engine unless stated in italics.

A —Ansani
Cir —Cirrus
C 6 —Curtiss
R-600—Curtiss Challenger
Co —Comet
Cy —Wright Cyclone
E —Wright Hispano-E
G —Genet
H —Henderson
179 —Irwin
J 5 —Wright Whirlwind
K —Kinner
L —Liberty
LB —Le Blond
LR —LeRhone
OX 5 —Curtiss
P Wh —Pratt & Whitney Hornet
P Ww —Pratt & Whitney Wasp
SR —Super Rhone
SH —Siemens Halske
Sz —Szekely
V —Velie
Wal —Walter
W —Warner
Wr —Hess Warrior
Y —Yanisee
* —Price without engine

PROPELLER:

CR —Curtiss Reed
F —Flottorp
H —Hamilton
Hs —Hartzell
M —Metal
Sty —Story
SS —Standard Steel
W —Wood
We —Westinghouse

FUSELAGE AND WING CO

B —Bolted
Cor —Corrugated
D —Duralumin
F —Fabric cover
Mon —Monocoque
O —Open section

BRAKES:

B —Bendix
Ex —Extra
H —Hydraulic

MERCIAL AIRPLANES AND SEAPLANES AS COMPILED BY *AVIATION*

***VIATION* DOES NOT ASSUME RESPONSIBILITY FOR THE FIGURES GIVEN**

monthly and corrections and suggestions are invited

(Lb. per Sq.Ft.)	Power Loading (Lb. per Hp.)	Performance with Full Load at Sea Level as Supplied by Manufacturers.						Fuel Capacity in Gallons	Normal Range in Miles	Normal Fuel Consumption at Cruising Speed Gal. Per Hr.	Fuselage Construction	Wing Construction	Are Wings Wired for Lighting?	Type of Control	Brakes	Type of Shock Absorber	Dept. of Commerce Type Certificate Number	Performance Figure Guaranteed?	
		High Speed in M.P.H.	Cruising Speed in M.P.H.	Landing Speed in M.P.H.	Climb at Sea Level in F.P.M.	Climb to 10,000' in Minutes	Service Ceiling in Feet												
.54	12.45	130	.....	39	1,080	.....	17,900	.....	.....	.....	Wl-ST	Wd-F	.....	SCD	.....	RC	56	.....	Alexander—Eaglerock A-1
.40	27.13	100	87	34	514	.....	11,500	46	435	10.3	Wl-ST	Wd-F	.....	SCD	.....	RC	7	Yes	Alexander—Eaglerock A-2
.93	14.54	121	.....	40	840	.....	14,700	.....	.....	.....	Wl-ST	Wd-F	.....	SCD	.....	RC	58	.....	Alexander—Eaglerock A-3
.15	13.20	125	100	40	1,050	.....	18,500	33	425	8	Wl-ST	Wd-F	Yes	D	Yes	RC	Apl	.....	Alliance Aircraft Corp.
.85	22.85	101	85	30	575	45	12,000	42	425	7.5	Wl-ST	Wd-F	Yes	SPD	Ex	RAR	17	Yes	American Eagle
.35	16.23	105	.....	36	680	.....	15,200	.....	.....	.....	Wl-ST	Wd-F	.....	S	.....	RC	.....	.....	Arrow—Sport
.77	10.00	150	110	45	1,100	12	18,000	170	500	32	Wd-P	Wd-F	Yes	DeCD	S-B	Hy-C	.....	Yes	Bach—Air Yacht
.82	13.5	145	110	48	1,250	.....	18,000	86	800	15	Wl-ST	Wd-F	Yes	SCD	Yes	RC	129	Yes	Bellanca—CH-300
.00	15.35	130	110	46	750	.....	16,000	86	.....	.....	Wl-ST	Wd-F	Yes	SCD	.....	.....	129	Yes	Bellanca—CH-300 Seaplane
.44	25.05	90	80	30	460	80	10,000	35	325	9	Wl-ST	Wd-F	Yes	SC PD	Ex	RC	Apl	Yes	Bird Wing—No. 6
.15	15.19	132	.....	57	800	16.5	15,100	140	.....	25	Wl-ST	Wd-F	Yes	S	S	O	27	.....	Boeing—40-B
.14	12.15	129	.....	57	600	25.3	12,000	140	.....	20	Wl-ST	Wd-F	Yes	S	S	O	54	.....	Boeing—40-C
.62	12.20	115	.....	59	1,000	18.5	12,000	80	.....	20	Wd	Wd-F	Yes	SD	.....	.....	.....	.....	Boeing—Model 204
.00	11.60	135	.....	55	900	.....	15,500	400	.....	.....	Wl-ST	Df	Yes	De	B	O-S	.....	.....	Beoing—Model 80-A
.90	11.10	140	.....	56	950	.....	15,500	130	.....	.....	Wl-ST-D	Wd-F	Yes	S	S	O	106	.....	Boeing—Model 95
.36	18.57	110	95	40	650	.....	14,000	43	600	6.5	Wl-ST	Wd-F	Yes	SPD	Op	RD	134	5%	Bourdon Kitty Hawk
.80	12.75	120	115	43	900	.....	15,500	80	550	9.5	Wl-ST	Wd-F	.....	.....	.....	RC	.....	.....	Breese
.70	15.00	140	120	45—50	.....	.....	.....	100	720	14	Wl-ST	Wd-F	Yes	SD	B	O	124	Yes	Buhl—CA-6
.92	16.66	125	110	45—50	1,000	.....	.....	42	400	10	Wl-ST	Wd-F	Yes	SPD	Ex	RAR	Apl	5%	Cessna Aircraft Co.
.17	18.24	125	115	45	1,000	.....	.....	42	400	10	Wl-ST	Wd-F	Yes	SPD	Ex	RAR	Apl	5%	Cessna Aircraft Co.
.80	12.10	150	125	45—50	1,400	.....	.....	42	400	12	Wl-ST	Wd-PF	Yes	SPD	Ex	RAR	Apl	5%	Cessna Aircraft Co.
.91	23.05	104	85	36	550	.....	10,000	.....	700	.....	Wl-ST	Wd-PF	Yes	S	No	RC	53	.....	Command-Aire
.30	13.10	140	118	45	1,100	15.5	17,500	95	400	15	Wl-ST	Da-F	Yes	S-PC-D	B	Arl	Apl	5%	Cunningham Hall—PT-6
.94	24.14	101	85	43.1	400	33.8	11,250	50	600	7	Wl-ST	Wd-FD	Yes	S-PC	No	O	68	5%	Curtiss—Robin OX-5
.70	15.29	120	101	45.5	640	18.7	12,700	50	536	.....	Wl-ST	Wd-F	Yes	S-PC	B	O	143	5%	Curtiss—Robin—R-600
.96	21 66	95	80	38	700	.....	10,000	20	350	4.5	Wl-ST	Wd-FD	No	DSPC	No	RC	Apl	5%	Davis—V-3
.75	21.33	103	.....	41	.....	.....	.....	25	425	5	Wl-ST	Wd-FD	.....	S-PC	.....	.....	.....	.....	Doyle—O-2
.94	16.67	96	80	25	590	.....	10,000	20	400	4	Wl-ST	Wd-F	Yes	SC	No	Elias	.....	.....	Elias—Aircoupe
.02	17.2	120	.....	.....	800	.....	17,000	23	.....	.....	Wl-ST	Wd-F	Yes	SpD	.....	RD	.....	.....	Fairchild—KR-21
.00	23.0	102	.....	.....	548	.....	12,000	33	.....	.....	Wl-ST	Wd-F	No	SpD	Yes	RC	.....	.....	Fairchild—KR-31
.40	14.5	130	.....	.....	886	.....	17,000	50	.....	.....	Wl-ST	Wd-F	Yes	SpD	.....	RD	.....	.....	KR—34-A
.56	13.75	138	110	55	1,050	.....	17,500	160	750	20	Wl-ST	Wd-F	Yes	SC	Yes	OS	89	Yes	Fairchild—71
.26	17.37	125	105	40	.....	.....	.....	84	750	10	Wl-ST	Wd	Yes	SC	Yes	Arl	.....	.....	Federal Aircraft—CM-1
.84	13.90	111	90	35	930	.....	16,000	24	350	.....	Wl-ST	D-Wd-F	.....	SPD	No	O	122	.....	Fleet Model 1
.73	13.33	126	105	46	830	.....	14,000	78	630	12	Wl-ST	Wd-P	Yes	SCD	Yes	RC	Apl	.....	Fokker Universal
.91	12.84	138	118	54	1,000	15	18,000	126	735	20	Wl-ST	Wd-P	Yes	SCD	Yes	RAR	52	5%	Fokker Super Universal
.41	10.91	140	118	55	1,400	10	18,000	360	765	60	Wl-ST	Wd-P	Yes	DeCD	Yes	RAR	96	.....	Fokker—F-10
.84	19.18	110	90	40	650	.....	12,150	40	540	.....	Wl-ST	Wd-F	Op	S	B	RC	117	Yes	General—Aristocrat
.33	14.35	135	115	50	950	20	16,000	140	600	21	D-cor	D-cor	Yes	De	Yes	Arl	.....	5%	Hamilton—H-45
.85	11.50	140	120	55	1,000	16	18,000	140	600	23	D-cor	D-cor	Yes	De	Yes	Arl	.....	5%	Hamilton—H-47
.47	22.39	70	65	32	200	.....	.....	3.3	120	.....	R-ST	Wd-F	No	SC	No	RC	.....	.....	Heath—Parasol
.49	23.33	100	87	35	600	.....	10,500	40	450	.....	Wd	Wd-F	Yes	S	Ex	O	35	.....	International—F-17
.41	18.75	125	110	40	850	.....	14,000	67	500	.....	Wd	Wd-F	.....	S	Stl	O	Apl	.....	International—F-18
.60	14.64	110	85	46	650	30	14,000	80	450	15	ST-D	Wd-F	Yes	DeD	No	O	153	5%	Ireland—Neptune
.47	23.60	90	75	28	400	65	12,000	8	300	1.7	Wd	Wd-F	Yes	SC	.....	RC	.....	6%	Irwin—M-T-2
.00	9.52	151	130	57	1,450	.....	17,400	500	750	.....	Wl-ST	.....	Yes	.....	Yes	O	.....	.....	Keystone—Patrician
.42	18.06	112	.....	57	570	.....	.....	.....	500	.....	Wl-ST	Wd-F	.....	.....	.....	.....	NC	.....	Keystone—Pathfinder
		130	.....	40	1,350	10	.....	80	600	.....	DT, S	Wd-F	.....	SPA	.....	.....	.....	.....	E. M. Laird—Commercial
.33	24.44	100	.....	35	600	.....	.....	42	500	.....	Wl-ST	Wd-F	.....	.....	.....	.....	28	.....	Lincoln—Page
.64	16.00	135	110	50	1,000	16	15,900	100	700	10	W-mon	Wd-P	Yes	SC	H	RC	Apl	5%	Lockheed—Vega
.25	9.11	167	135	55	1,460	10	17,250	100	1,000	18	W-mon	Wd-P	Yes	SC	H	RC	Apl	5%	Lockheed—Air Express
.41	11.23	130	105	55	.....	.....	15,000	140	550	28	Wd-D	Wd-F-D	Yes	DeD	No	Arl	90	.....	Loening—Amphibian
.30	13.30	140	120	50	1,200	10	18,000	100	7-800	14	Wl-ST	Wd-F	Yes	SDP & C	B	Arl	142	5%	Mahoney—Ryan B-5
.34	13.65	135	115	48	800	.....	16,000	150	1,000	21	Wl-ST, D	D	Yes	D DeCP	B	Arl	.....	5%	Allmetal Flamingo—G-2-W
.34	10.66	140	120	48	1,200	.....	19,000	150	900	25	Wl-ST-D	D	Yes	D DeCP	B	Arl	.....	5%	Allmetal Flamingo—G-2-H
.43	21.36	90	75	35	700	.....	.....	.....	.....	.....	Wl-ST	Wd-F	Yes	S Pl	.....	RAR	.....	.....	Mono Aircraft—Monocoupe
.88	24.54	100	85	35	650	.....	10,000	22	350	4.6	Wl-ST	Wd-F	No	S Pl	No	Grs	95	Yes	Mohawk—Pinto
.71	18.88	115	90—95	37	750	18	16,000	64	480	12	DR-F	Wd-F	Yes	SCP	Ex	O-S	107	5%	New Stand Aircraft Corp.—D-24
.40	20.80	103	90	38	500	25	9,000	42	465	7	Wl-ST	Wd-F	Yes	SPD	Yes	P	Apl	Yes	Paramount Cabinaire—No. 110
.10	15.2	120	105	40	800	.....	12,000	52	400	.....	Wl-ST	Wd-F	.....	SPD	.....	P	Apl	.....	No. 165
.35	23.13	100	90	35	500	.....	12,500	38	400	9	Wl-ST	Wd-F	Ex	SPD	Ex	RC	56	.....	Pheasant—H10
.96	12.56	136	105	45	1,600	.....	11,000	60	600	.....	Wl-ST	Wd-F	Yes	S	Yes	Arl	18	5%	Pitcairn—PA-5
.10	13.80	144	.....	50	.....	.....	.....	.....	.....	.....	Wl-ST	Wd-F	.....	S	.....	O	92	.....	Pitcairn—PA-6 Super Mailwing
.10	13.80	144	.....	50	.....	.....	.....	.....	.....	.....	Wl-ST	Wd-F	.....	S	.....	O	92	.....	Pitcairn—PA-6 Sport Mailwing
.51	16.87	95	.....	45	.....	.....	.....	42	.....	.....	Wd-D	Wd-F	.....	DeCP	.....	.....	.....	.....	Richmond Airways—Sea Hawk
.29	15.00	122	112	58	650	.....	15,000	370	790	50	DOR, B	DOR, B	.....	DeD	Hy	RDO	Apl	5%	Sikorsky—S57
.88	12.50	125	110	55	880	15	19,400	200	500	36	Wd-D	DOR, B	Yes	DeD	.....	DOS	60	5%	Sikorsky—S38 Amphibion
.10	19.80	125	110	38	1,000	20	12,000	40	600	6.5	Wl-ST	Wd-F	Yes	S	Op	Hy	43	5%	Simplex—Red Arrow K-2-S
.10	16.20	125	110	38	1,100	17	14,000	40	550	7.0	Wl-ST	Wd-F	Yes	S	Op	Hy	.....	5%	Simplex—Red Arrow W-2-S
.50	14.00	135	110	47	900	.....	15,000	120	825	16	Wl-ST	Wd-F	Yes	SPC	Yes	Arl	Apl	5%	Stearman—Coach
.40	11.60	148	120	45	1,100	.....	18,000	100	800	15	Wl-ST	Wd-F	Yes	SPC	Yes	RHy	Apl	5%	Stearman—Sport Commercial
.41	22.50	125	105	56	900	.....	14,000	90	750	11	Wl-ST	Wd-F	Yes	DeD	Stl	Hy	74	.....	Stinson—SM-1-D
.59	22.72	110	90	46	500	.....	13,500	42	500	7	Wl-ST	Wd-F	Yes	DS	Stl	Hy	48	5%	Stinson—Junior
.33	15.92	115	100	37	800	12.5	18,000	50	600	8	Wl-ST	Wd-F	Yes	DS	No	RC	73	Yes	Spartan—C-3
.90	11.25	130	110	58	950	17	14,500	231	560	45	D-cor	D-cor	Yes	DeD	Hy	RC	132	Yes	Stout—Ford—4-AT-E
.16	10.6	133	113	64	950	16	16,500	277	525	60	D-cor	D-cor	Yes	DeD	Hy	RC	165	Yes	Stout—Ford—4-AT-E
.33	24.44	100	.....	35	600	.....	.....	36	500	.....	Wl-ST	Wd-F	.....	.....	.....	RC	21	.....	Swallow—Commercial
.20	20.00	90	80	30	600	.....	11,000	10	360	.....	Wl-ST	Wd-F	.....	SC	No	RAR	Apl	.....	Szekely Flying Dutchman
.57	15.00	110	100	38	850	.....	.....	30	500	6	Wl-ST	Wd-F	Yes	SP	.....	RAR	.....	Yes	Taylor Bros.—Chummy
.00	11.25	.....	.....	.....	.....	.....	.....	50	.....	.....	Wl-ST	Wd-F	.....	S	.....	.....	.....	.....	Texas—Temple
.00	14.50	125	100	50	900	19	14,000	67	508	13.2	Wl-ST	Wd-F	Yes	SPCD	B	O	146	Yes	Travel Air—B-4000
.80	15.30	126	103	46	800	.....	.....	67	.....	.....	Wl-ST	Wd-F	Yes	SPCD	Bex	C	149	Yes	Travel Air—D-4000
.80	21.00	105	90	43	525	.....	.....	67	720	8.3	Wl-ST	Wd-F	Yes	SPCD	Bex	C	112	Yes	Travel—W-4000
.80	14.10	130	110	60	800	19	16,000	82	500	18	Wl-ST	Wd-F	Yes	DeCD	B	O	130	Yes	Travel Air—6000B
.20	13.10	138	120	60	1,000	15	18,000	130	680	23	Wl-ST	Wd-F	Yes	DeCD	B	O	116	Yes	A-6000-A
.08	22.50	96	85	35	500	.....	13,000	48	.....	8	Wl-ST	Wd-F	Yes	SPD	Ex	OS	13	.....	Waco "90"
.10	15.15	120	100	44	700	.....	18,000	65	.....	10	Wl-ST	Wd-F	Yes	SPD	B	.....	168	.....	Waco "165"
.10	11.80	125	105	44.5	1,000	.....	19,000	65	.....	12	We-ST	Wd-F	Yes	SPD	B	.....	41	.....	Waco "220" Straight Wing
.45	11.80	135	110	52	1,100	.....	19,000	87	.....	12	Wl-ST	Wd-F	Yes	SPD	B	.....	123	.....	Waco "220" Taper Wing
...	20.41	104	95	30	900	.....	16,000	40	400	.....	Wl-ST	Wd-F	Yes	SD	Ex	HyC	Apl	5%	Waldron Starling
.90	21.00	115	100	43	800	27	14,000	32	500	6.4	Wl-ST	Wd-F	Yes	SPD	Yes	OS	119	.....	Wallace—Touroplane-Model "B"
.94	21.11	97	90	35	600	.....	14,000	40	350	8	Wd-WIS	Wd-F	No	S	.....	C	Apl	5%	Whites—Humming Bird
.30	16.70	102	85	35	750	.....	17,000	24	430	4.8	Wl-ST	Wd-F	Yes	SCD Pl	No	R	.....	.....	Whittelsey Avian

LAGE AND WING CONSTRUCTION:

Bolted
Corrugated
Duralumin
Fabric cover
Monocoque
Open section

KES:

Bendix
Extra
Hydraulic

P —Plywood cover
R —Riveted
S —Steel
T —Tubing
Wd —Wood
Wl —Welded
L —Lockheed
O —Optional
S —Sausedde
Std —Standard

LIGHTS:

N —Navigation lights
Op—Optional

CONTROL:

A —Arens
C —Cables
D —Dual
De—Wheel
P —Push rods
S —Stick
Pl —Pedal

SHOCK ABSORBER:

Arl —Aerol
C —Cord
D —Compression
Grs —Gruss
Hy —Hydraulic
O —Oleo
P —Pneumatic
R —Rubber
RAR—Rusco Aero Rings
S— —Coil Spring
T —Trombone

TYPE CERTIFICATE:

Apl —Applied for and is pending

GUARANTEE:

N —New

MANUFACTURERS' SPECIFICATIONS ON ENGINES AVAILABLE FOR COMMERCIAL USE AS COMPILED BY *AVIATION*

THE TABLE BELOW IS BELIEVED TO BE ACCURATE BUT *AVIATION* DOES NOT ASSUME RESPONSIBILITY FOR THE FIGURES GIVEN

This table will appear monthly and corrections and suggestions are invited

MANUFACTURER OR AGENT	Engine	Cooling System	Cylinder Arrangement	No. of Cylinders	No. of Cycles	Propeller Drive	Rated Hp. and R.P.M. at Sea Level	Maximum Hp. and R.P.M. at Sea Level	Weight Dry Without Hub or Starter	Weight Per Rated Hp.	Bore and Stroke (in.)	Compression Ratio	B.M.E.P.	Displacement (Cu.in.)	Frontal Area (Sq.Ft.)	Diameter of Mounting Ring or Distance Between Bearers (in.)	Height or Overall Diameter (in.)	Length Without Starter (in.)	Guaranteed Fuel Consumption at Rated Hp. Lb./Hp. Hr.	Oil Consumption Lb./Hp. Hr.	Valve Mechanism	Cylinder Construction (See Key)	No. Intake Valves Per Cylinder	Make Spark Plugs Supplied with Engine	No. Exhaust Valves Per Cylinder	Type of Ignition	Make Ignition	No. Carburetors	Make Carburetors	Make Starter	Are Exhaust Manifolds Provided	Shipping Weight Crated	Dept. of Commerce License	Cost at Factory
Allison Engineering Co	V1410	A	IV-45°	12	4	D	410–1800	430–1900	1000	2.44	4½x7	5.3	128	1410	....	17	46¾	78½	.55	.03	ohc	Al, S	1	BG	1	2B	De	1	Sg[2]	Ec	....	....	Y	.....
Allison Engineering Co	VG1410	A	IV-45°	12	4	G[1]	410–1800	430–1900	1125	2.62	4½x7	5.3	128	1410	....	17	.....	85⅛	.55	.03	ohc	Al, S	1	BG	1	2B	De	1	Sg[2]	Ec	....	....	Y	.....
Allison Engineering Co	V1650	W	IV-45°	12	4	D	420–1700	450–1800	885	2.10	5 x7	5.4	122	1650	....	17	46 7/16	74¼	.53	.025	ohc	Al, S	1	BG	1	2B	De	1	Sg	Ec	....	....	Y	.....
American Cirrus Engines	Cirrus Mark III	A	L	4	4	D	95–2100	98–2100	275	2.90	4⅜x5⅛	5.4	122	310	....	18¾	36⅜	38½	.54	021	prr	Al, S	1	BG	1	2M	Sc	1	Sg	Op	Y	400	N	1,600
Axelson Machine Co	Axelson A7R	A	Rad	7	4	D	150–1800	.....	430	2.87	4½x5½	4.7	....	612	....	16¼	45½	35	.52	.017	prr	Al, S	1	RB	1	M	Sc	1	Sg	SAE	....	750	16	2,900
Comet Engine Corp	Comet	A	Rad	7	4	D	150–1800	.....	393	2.62	4½x5½	5.1	....	612	....	17½	46⅞	35⅝	.....	.....	prr	Al, S	1	.....	1	2M	Sc	1	Sg	Bs	....	800	9	.....
Curtiss Aeroplane & Motor Co.	OX-5	W	V-90°	8	4	D	90–1400	.....	375	4.17	4 x5	4.9	....	502	....	12⅞	.....	.....	.55	.030	prr	Mo, C	1	AC	1	1M	....	1	Z	....	N	....	Y	.....
Curtiss Aeroplane & Motor Co	OXX6	W	V-90°	8	4	D	110–1900	.....	390	3.55	4¼x5	4.9	....	568	....	12⅞	.....	.....	.55	.030	...	Mo, C	1	.....	1	2M	.....	1	Z	....	N	....	Y	.....
Curtiss Aeroplane & Motor Co.	C-6A	W	L	6	4	D	160–1700	165–1750	420	2.62	4½x6	5.2	133	573	....	15¾	39	57 15/32	.52	.015	ohc	Al, Al, S	2	AC	2	2M	Sp	1	Z	U	N	865	Y	.....
Curtiss Aeroplane & Motor Co.	D12	W	V-60°	12	4	D	435–2300	460–2500	680	1.47	4½x6	5.3	135	1145	....	15¾	.....	56¾	.52	.015	ohc	Al, Al, S	2	BG	2	2M	Sc	1	Sg	Ec	N	1080	12	.....
Curtiss Aeroplane & Motor Co.	Conquerer	W	V-60°	12	4	D	600–2400	635–2450	760	1.26	5½x6¼	5.8	130	1569	....	15¾	.....	56¾	.52	.015	ohc	Al, Al, S	2	BG	2	1M	Sp	2	Z	Ec	N	1060	6	.....
Curtiss Aeroplane & Motor Co., Inc.	Geared Conquerer	W	V-60°	12	4	G[2]	600–2400	625–2450	850	1.42	5⅛x6¼	5.8	128	1569	....	15¾	.....	56 5/32	.52	.015	ohc	Al, Al, S	2	BG	2	1M	Sp	2	Sg	Ec	N	1150	7	.....
Curtiss Airplane & Motor Co.	Chieftain	A	H	12	4	D	600–2200	615–2200	900	1.50	5⅝x5½	5.4	130	1690	....	23⅜	45¼	51 1/16	.60	.025	ohc	Al, S	2	BG	2	DM	Sc	2	Sg	E	N	1325	8	.....
Curtiss Airplane & Motor Co.	Challenger	A	Rad. 8	6	4	D	170–1800	180–1800	420	2.47	5½x4⅞	5.2	124	603	....	19	41¾	35 5/32	.55	.020	prr	Al, S	1	BG	1	2M	Sc	1	Sg	E	N	850	5	.....
Dayton Airplane Engine Co.	Bear	A	L	4	4	D	110–1550	120–1800	375	3.41	4½x7	5.3	118	445	....	16	38⅝	54 27/32	.525	.0125	ohc	Al, NI	1	BG	1	2M	BR	1	Z	N	N	550	11	1,450
Hallet Mfg. Co.	H-526	A	Rad	7	4	D	130–1800	.....	425	3.26	4¾x5	5.2	....	526	....	18½	46	37	.....	.....	prr	C	1	BG	1	2M	BR	1	Z	....	N	....	N	1,700
Irwin Aircraft Co.	Irwin 79	A	Rad	4	2	D	20–1700	25–2200	60	3.00	2⅞x2¾	5.0	110	79	2.0	4⅞	23	11	.45	.0311	Au	Aa, Aa, S	1	RB	1	1M	BR	2	Wf	....	N	100	N	625
Kinner Airplane & Motor Corp.	K-5	A	Rad	5	4	D	110–1825	112–1860	285	2.58	4.25x5.25	5.0	....	372	....	14	44⅜	32¼	.55	.035	prr	Al, S	1	BG	1	2M	Sc	1	Sg Hy	H	N	500	3	1,800
Kimball Aircraft Corp.	Beetle, Model K	A	Rad	7	4	D	135–1850	.....	378	2.77	4½x5¼	5.0	100	585	....	17	45	37¾	.....	.....	prr	Al, NI	1	.....	1	2M	Sc	1	Sg	Ec	.....	.....	.....	.....	.....
Le Blond Aircraft Engine Corp.	60 Model 5-D	A	Rad	5	4	D	65–1950	69–1950	230	3.54	4½x3¾	5.3	112	250	5.85	.....	32¾	22 5/16	.58	.013	prr	IC	1	AC	1	DM	Sc	1	Sg	Ec	N	460	12	1,230
Le Blond Aircraft Engine Co.	90 Model 7-D	A	Rad	7	4	D	90–1975	94–1975	285	3.16	4½x3¾	5.3	109	350	....	.....	32¾	22 5/16	.58	.013	prr	IC	1	AC	1	DM	Sc	1	Sg	Ec	N	510	....	1,610
Menasco Motors Co.	B-2 Salmson	A	Rad	9	4	D	260–1500	278–1760	542	2.08	4.92x6.69	5.2	....	.....	.....	.....	49¼	38½	.42	.025	prr	Al, S	1	.....	1	2M	O	1	Z	....	.....	.....	.....	3,250
Michigan Aero Engine Co.	Rover	A	LI	4	4	D	55–1800	.....	210	3.81	3⅞x5	5.0	....	236	.....	.....	.....	.....	.....	.....	prr	NI	1	.....	1	2M	Sc	1	Sg	N	.....	.....	.....	.....
Packard Motor Car Co.	1A-2775	W	X-60°	24	4	D	1200–2600	1300–2700	1500	1.15	5¾x5	7	150	2775	6.22	14¼	45 11/32	78 1/16	.52	.03	ohc	S	2	BG	2	4B	Sc	4	Sg	O	V	....	N	35,000
Packard Motor Car Co.	3A-1500	W	V-60°	12	4	D	600–2500	650–2700	760	1.26	5⅜x5½	5.5	140	1530	4.03	15¾	38 15/64	62 11/32	.52	.015	ohc	S	2	BG	2	2M	Sc	2	Sg	Ae	N	1275	Y	12,000
Packard Motor Car Co.	3A-1500	W	V-60°	12	4	G	600–2500	650–2700	880	1.46	5⅜x5½	5.5	140	1530	4.03	15¾	38 15/64	65	.52	.025	ohc	S	2	BG	2	2B	De	2	Sg	Ae	N	1390	Y	17,375
Packard Motor Car Co.	3A-1500	W	V-60°	12	4	D	600–2500	650–2700	780	1.30	5⅜x5½	5.5	140	1530	4.03	16¼	38⅝	62 11/32	.52	.025	ohc	S	2	BG	2	2M	Sc	2	Sg	Ae	N	1275	N	12,000
Packard Motor Car Co.	3A-2500	W	V-60°	12	4	D	800–2000	835–2100	1160	1.45	6⅜x6½	5.7	135	2539	4.8	18¼	36¼	69⅜	.52	.015	ohc	S	2	BG	2	2M	Sc	2	Sg	Ae	N	2150	19	15,625
Packard Motor Car Co.	3A-2500	W	V-60°	12	4	G	800–2000	835–2100	1380	1.72	6⅜x6½	5.7	135	2539	5.1	18¼	36⅛	76½	.52	.015	ohc	S	2	BG	1	2B	De	2	Sg	Ae	N	2340	Y	19,375
Pratt & Whitney Aircraft Co.	Wasp	A	Rad	9	4	D	420–2000	450–2100	690	1.64	5¾x5¾	5.2	124	1344	....	23⅜	.....	43⅝	.55	.035	prr	Al, S	1	BG	1	2M	Sc	1	Sg	....	N	1150	14	7,200
Pratt & Whitney Aircraft Co.	Geared Wasp	A	Rad	9	4	G[2]	420–2100	.....	760	1.80	5¾x5¾	5.2	124	1344	....	23⅜	.....	47	.55	.035	prr	Al, S	1	BG	1	2M	Sc	1	Sg	....	N	1300	....	8,200
Pratt & Whitney Aircraft Co.	Hornet	A	Rad	9	4	D	525–1900	.....	785	1.40	6⅛x6⅜	5.0	123.5	1690	....	23⅜	55 1/16	44⅝	.55	.035	prr	Al, S	1	BG	1	2M	Sc	1	Sg	Ec	N	1400	15	8,500
Pratt & Whitney Aircraft Co.	Geared Hornet	A	Rad	9	4	G[2]	525–1900	.....	855	1.62	6⅛x6⅜	5.0	123.5	1690	....	23⅜	55 1/16	48	.55	.035	prr	Al, S	1	BG	1	2M	Sc	1	Sg	Ec	N	1525	Y	9,500
Quick Motors Co.	Quick-Radial	A	Rad	9	4	D	125–1450	.....	325	2.6	4.13x5.51	5	....	667	.....	19 5/16	36	.....	.....	.....	prr	Al, S	1	CH	1	1M	Sc	1	Z	....	.....	.....	.....	1,750
Siemens & Halske A. G.*	Yankee "5"	A	Rad	5	4	D	83–1710	.....	246	2.96	4.13x4.72	5.3	....	317	....	14	39⅝	34	.52	.022	prr	Al, S	1	O	1	2M	O	1	Sm	O	Y	693	Ex	2,100
Siemens & Halske A. G.*	Yankee "7"	A	Rad	7	4	D	113–1720	.....	308	2.72	4.13x4.72	5.3	....	443	....	14	39⅝	32	.52	.022	prr	Al, S	1	O	2	Sm	O	Y	726	Ex	2,500
Siemens & Halske A. G.*	Yankee "9"	A	Rad	9	4	D	128–1735	.....	382	2.98	3.94x4.72	5.3	....	517	....	14.6	40½	32	.52	.022	prr	Al, S	1	O	2	Sm	O	Y	800	Ex	2,527
Spartan Aircraft Co.	Walter 5	A	Rad	5	4	D	70–1600	.....	225	3.21	4.13x4.72	4.4	112	317	....	11.35	37	27.5	.50	.028	prr	Al, S	1	AC	1	2M	Sc	1	So	....	Y	500	Y	1,835
Spartan Aircraft Co.	Walter 7	A	Rad	7	4	D	95–1600	.....	280	2.95	4.13x4.72	4.4	108	444	....	12.6	37	28.5	.49	.026	prr	Al, S	1	AC	1	2M	Sc	1	Z	....	Y	580	Y	2,355
Spartan Aircraft Co.	Walter 9	A	Rad	9	4	D	135–1750	.....	352	2.59	4.13x4.72	4.4	112	572	....	14.56	39	33.5	.49	.026	prr	Al, S	1	AC	1	2M	Sc	1	DuZ	....	Y	670	Y	2,940
Ssekely, O. E., Corp.	SR-3	A	Rad	3	4	D	40–1800	45.6–1900	148	3.7	4¾x4¾	4.8	100	191	2.3	9⅞	.....	23¾	.57	.030	prr	C	1	.....	1	2M	BR	1	Z	N	N	205	....	765
Tips & Smith, Inc.†	Super-Rhone	A	Rad	9	4	D	125–1450	133–1650	315	2.52	4¼x5½	5.2	.....	667	4.75	11	.....	39	.31	.036	prr	S, C	1	Sp	1	1M	Dx	1	Z	....	.....	400	N	2,250
Velie Motors Corp.	Velie M5	A	Rad	5	4	D	45–1750	.....	210	4.66	4¼x3¾	5.2	.....	250	.....	12¾	32	27	.55	.025	prr	Al, S	1	AC	1	2M	Sc	1	Z	Ec	Y	420	4	1,050
Warner Aircraft Corp.	Scarab	A	Rad	7	4	D	110–1850	120–1925	270	2.45	4¼x4¼	5.2	112	422	....	17	35½	27½	.50	.01	prr	Al, S	1	AC	1	2M	Sc	1	Sg	....	N	....	2	2,485
Wright Aeronautical Corp.	Whirlwind Five	A	Rad	5	4	D	165–2000	.....	370	2.46	5 x5½	5.0	.....	540	....	19¼	45	28 29/32	.55	.035	prr	Al, S	1	.....	1	2M	Sc	1	Sg	....	Y	850	23	3,000
Wright Aeronautical Corp.	Whirl'ind Seven	A	Rad	7	4	D	225–2000	.....	425	1.08	5 x5½	5.0	.....	756	....	19¼	45	28 29/32	.55	.035	prr	Al, S	1	.....	1	2M	Sc	1	Sg	....	Y	870	Y	.....
Wright Aeronautical Corp.	Whirl 'ind Nine	A	Rad	9	4	D	300–2000	.....	485	1.61	5 x5½	5.0	.....	975	....	19¼	45	28 29/32	.55	.035	prr	Al, S	1	.....	1	2M	Sc	1	Sg	....	Y	1000	21	4,800
Wright Aeronautical Corp.	Whirlwind J5	A	Rad	9	4	D	220–2000	225–2000	500	2.50	4½x5½	5.2	123	788	....	19¼	45	33¾	.53	.035	prr	Al, S	1	AC	1	2M	Sc	1	Sg	....	N	1000	13	3,900
Wright Aeronautical Corp.	Cyclone R1750	A	Rad	9	4	D	525–1900	560–2000	760	1.52	6 x6⅞	5.0	130	1753	....	23⅜	53 15/16	40⅝	.55	.035	prr	Al, S	1	BG	1	2M	Sc	1	Sg	....	N	1530	17	8,600
Wright Aeronautical Corp.	Gipsy	A	L	4	4	D	85–1900	100–2100	245	2.88	4½x5	5.0	.....	318	....	11 13/16	.....	45¼	.55	.010	prr	Al, C	1	.....	1	2M	Sc	1	Sg	....	.....	500	3E	.....

*— Engines of foreign manufacture
†— Rebuilt
a— Applied for
A— Air cooled
Aa— Aluminum alloy
Ae— Aeromarine
Al— Aluminum
AS— Ansani or Scintilla
Au— Automatic
B— Battery ignition
BR— Robert Bosch
Bs— Scintilla booster magneto

C— Cast iron
Ch— Champion
Cylinder Construction
first—head
second—walls or waterjacket
third—sleeve, if any
D— Direct
De— Delco
Du— Duplex
Dx— Dixie
DM— Dual Magneto
Ec— Eclipse

E— Ensign
Ex— Extra
G— Geared
G[1]— 5:3 epicyclic gear
G[2]—2:1 reduction gear
GE— General Electric
H— Hexagonal
Hy— Holley
I— Inverted
Ic— Cast Iron
L— Cylinders in line
Mo— Monel

M— Magnetic
NI— Nickel Iron
N— No
Op— Optional
O— Own
Ohc— Overhead cam
prr— Push rods and rocker arms
Rad— Radial
Rad S— Staggered Radial
S. A. E.—S. A. E. Mounting
Sc— Scintilla
Sg— Stromberg

Sg[1]— Stromberg NA-U5 duplex
Sg[2]— Stromberg NAS-8E
Sm— Sum
So— Solex
Sp— Splitdorf
S— Steel
U— U.S.L. Electric
V— Vee
W— Water cooled
Wf— Winfield
X— Extra
Y— Yes Z—Zenith

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HOLLAND, MICHIGAN.

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Nickel Alloy Steel crankshaft and master rod assembly used in Hess-Warrior 7-cylinder 125 H.P. airplane engine manufactured by THE ALLIANCE AIRCRAFT CORP., *Alliance, Ohio.*

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	SAE No.
Crankshaft	3140
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Connecting rods	3140
Articulating rods	3140
Cam ring	2512
Tachometer drive shaft	3140
Rocker	3140
Magneto coupling	3140
Valve spring lower retainer	3140
Valve spring upper retainer	3140
Valve spring retainer lock cap	3140
Pump and magneto gear plug	3140
All nuts and bolts	3140
All gears	3250
All keys	3140

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Another aircraft engine using dependable NICKEL STEEL parts

RUGGED, smooth-running, light in weight, the Hess-Warrior aircraft engine used in the Argo airplane is designed to meet the fast plane requirements of dependable power and good maneuverability.

All materials employed in the Hess-Warrior engine conform to rigid Army and Navy standards. Nickel Alloy Steel is used for the crankshaft, master rod assembly, gears, piston pins, and all studs and bolts—parts that must afford utmost dependability and maximum wear-resistance.

Nickel
FOR ALLOY STEEL

After 400 hours of flying, a Hess-Warrior engine was recently disassembled at the factory and found to be in perfect condition. Practically no signs of wear were noted on the important vital parts. In the manufacture of airplane engines the uniform, dependable mechanical properties of Nickel Alloy Steels have been unquestionably established. Today, both in America and Europe, all leading manufacturers of aircraft engines use Nickel Alloy Steel for parts that must withstand wear and high stresses.

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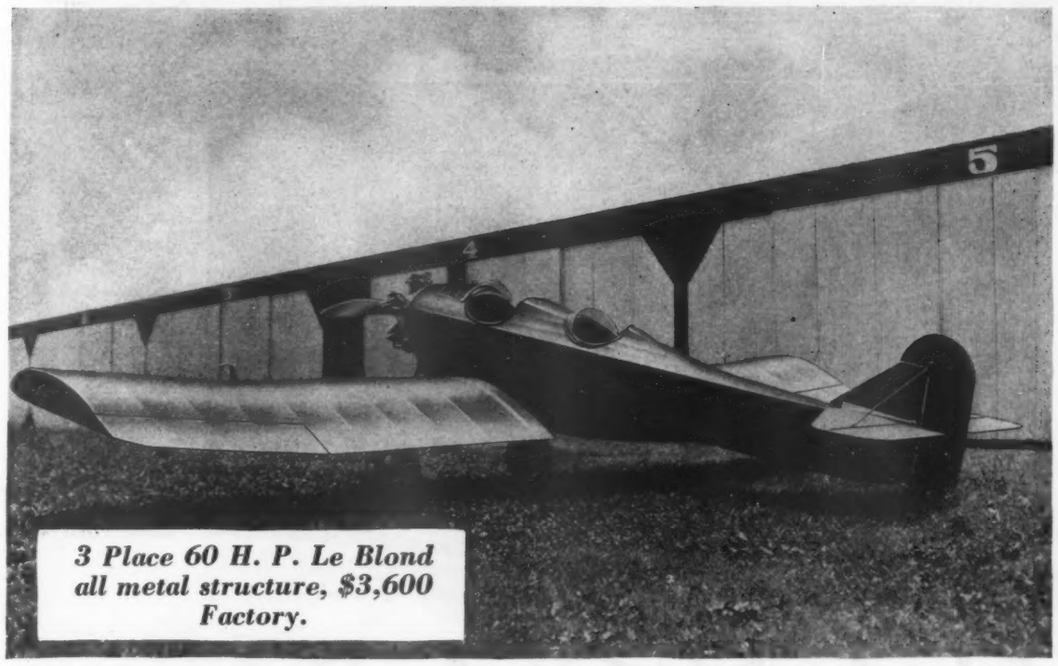

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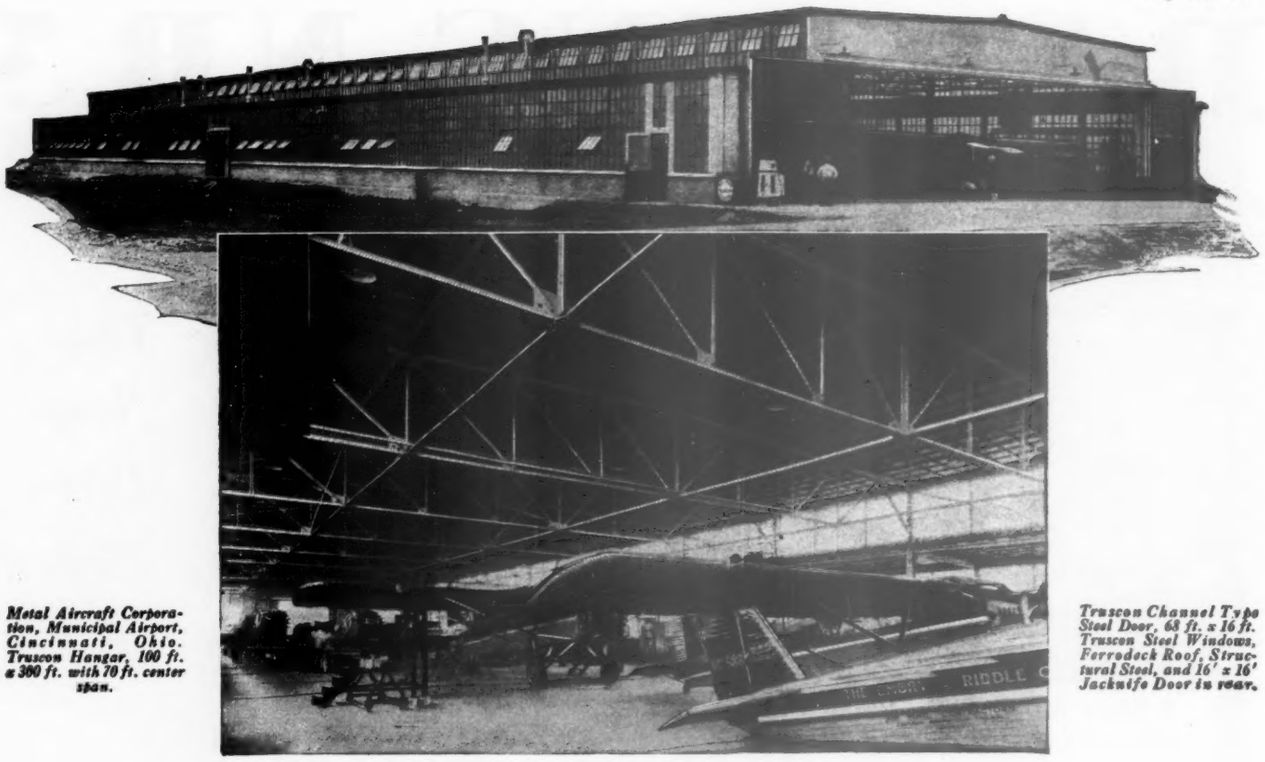

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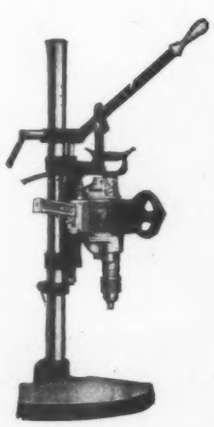

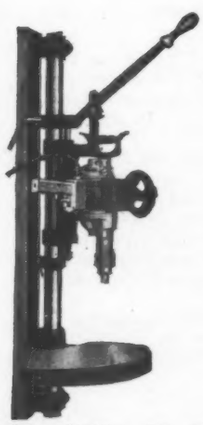

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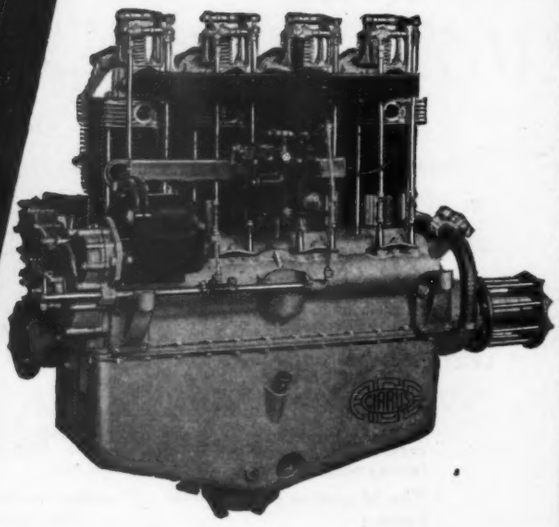

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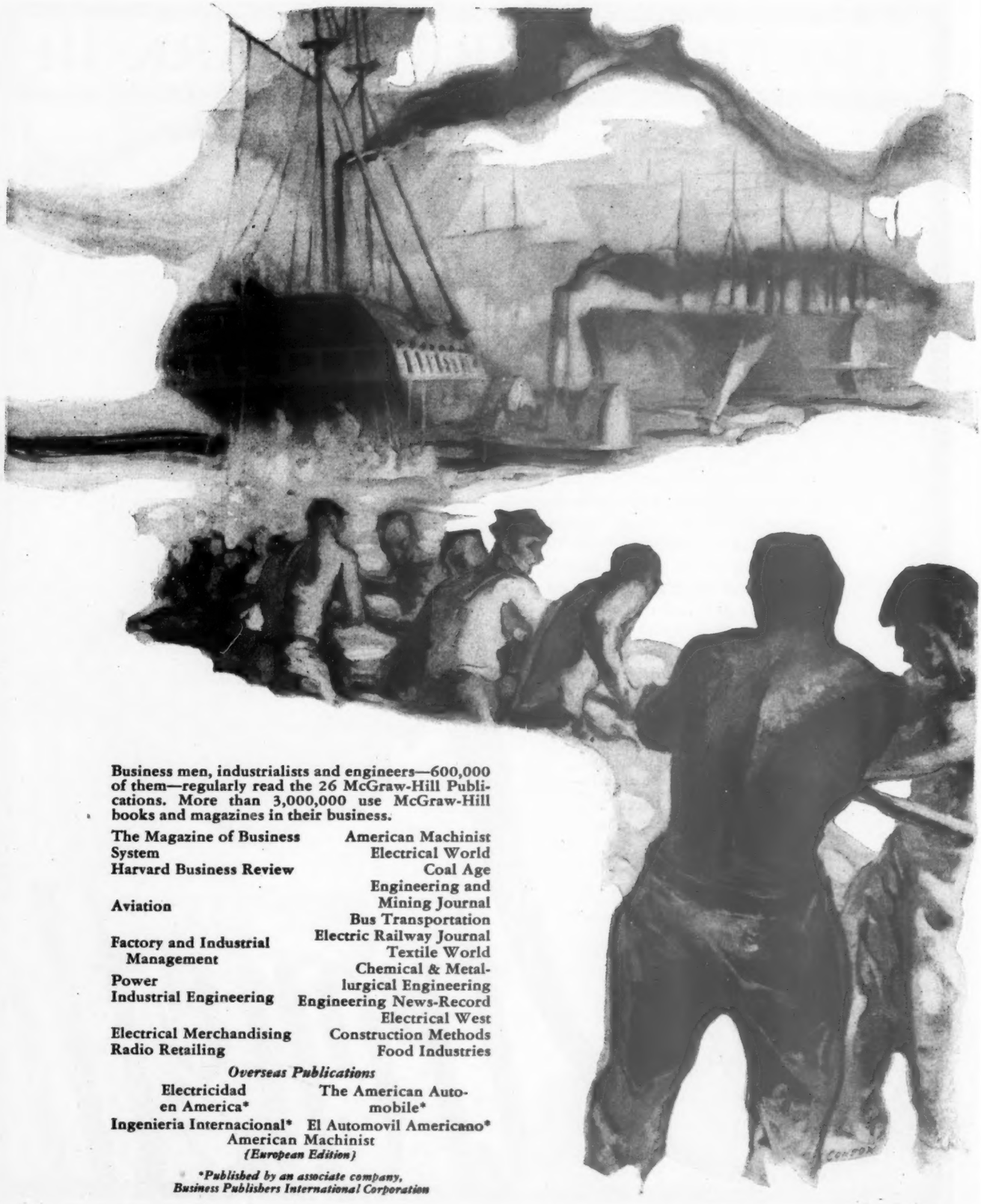

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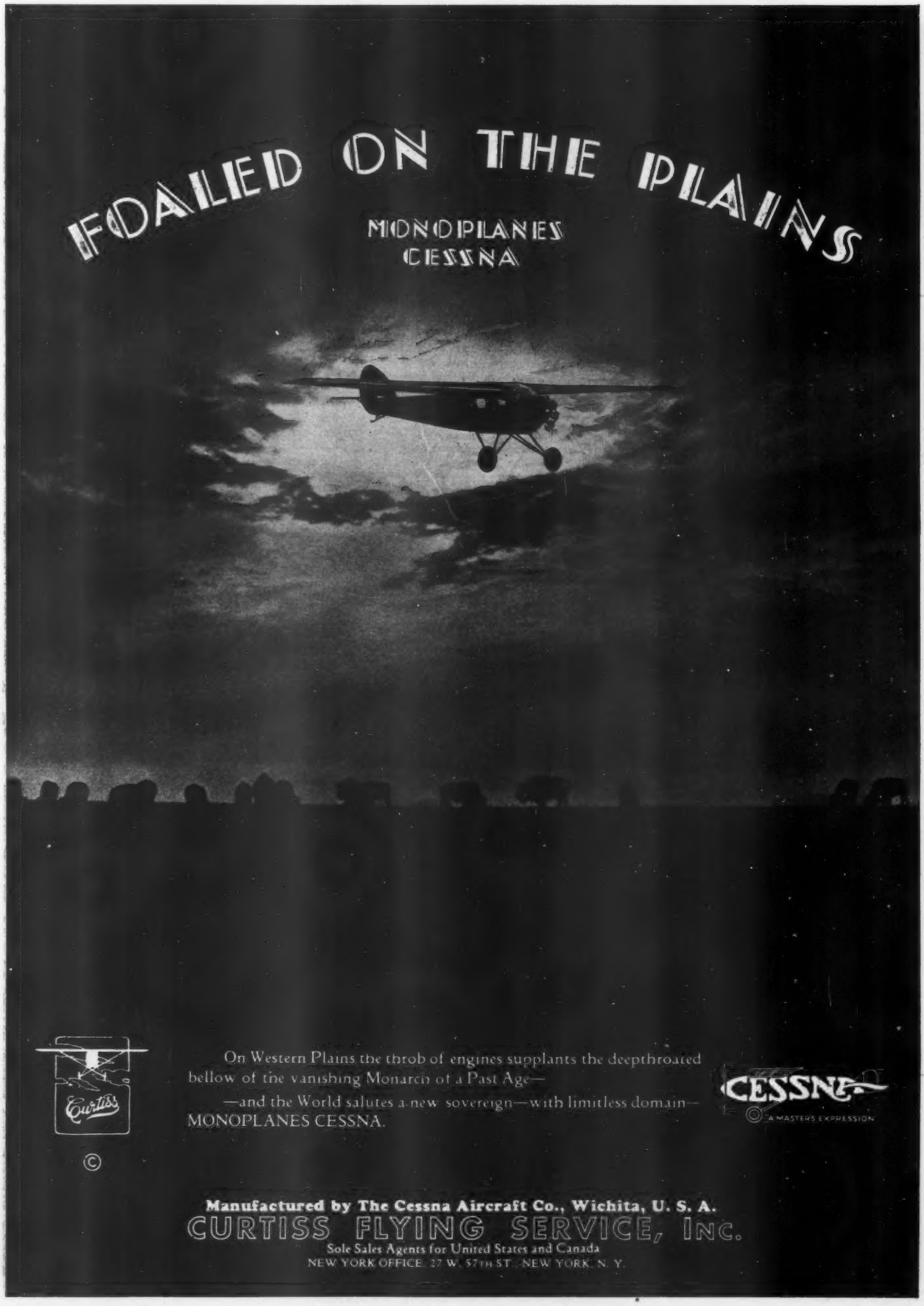
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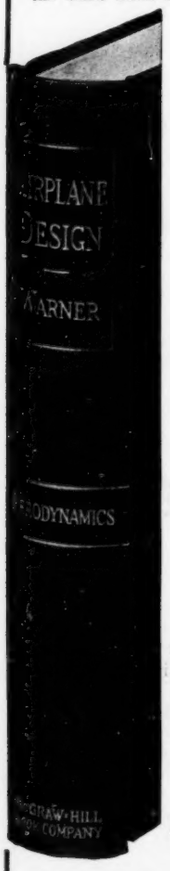

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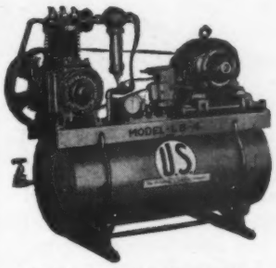

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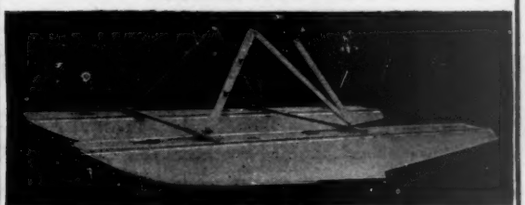

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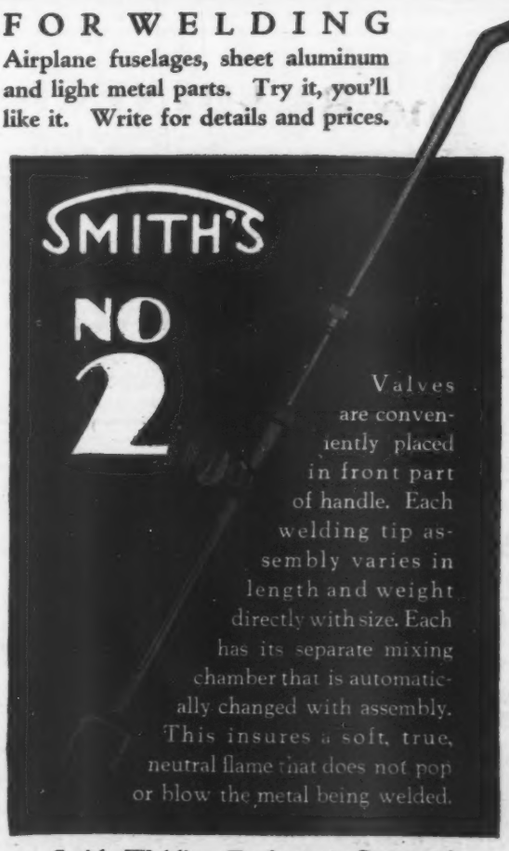
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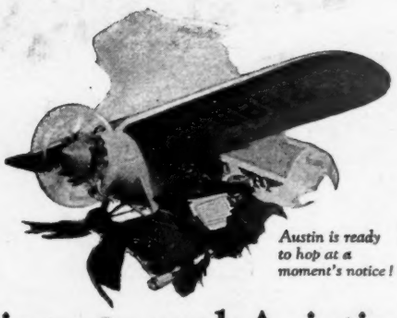

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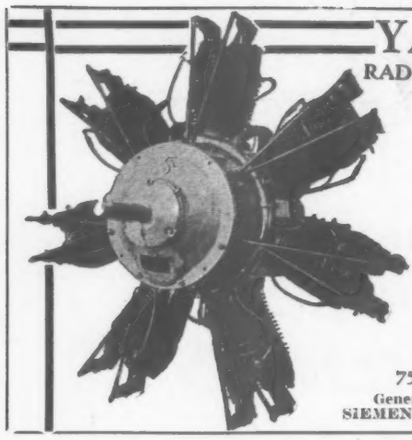

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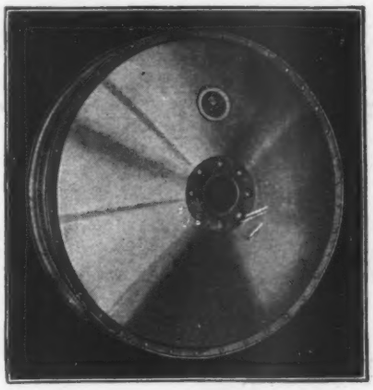

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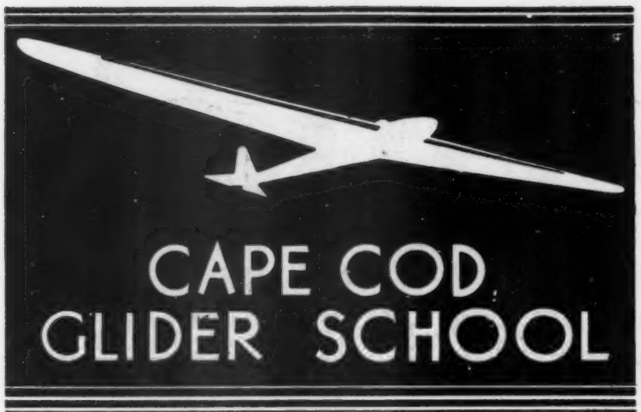

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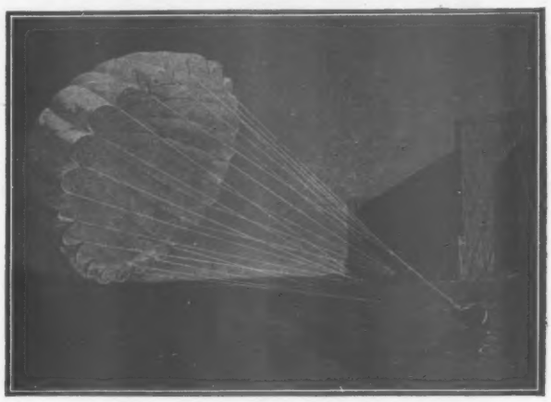

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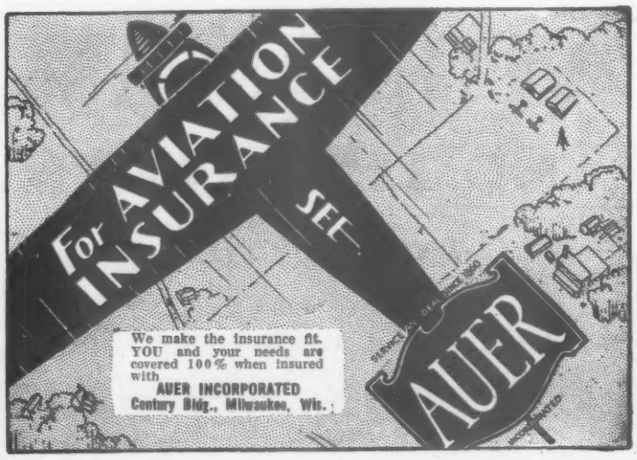
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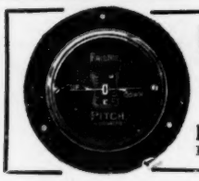

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Dealers, Wisconsin, Challenger and Fairchild Airplanes.
Capt. L. G. Mulzer, Gen. Mgr.
Wisconsin Rapids, Wis.

The fact that schools advertising in the WHERE TO FLY section of AVIATION have done so over a period of years is one of the best testimonials to the efficiency of this type of advertising.

SEARCHLIGHT SECTION

EMPLOYMENT and BUSINESS OPPORTUNITIES—USED and SURPLUS NEW EQUIPMENT

UNDISPLAYED—RATE PER WORD:

Positions Wanted, Positions Vacant, and all other classifications, excepting equipment, 10 cents a word, minimum $2.50 an insertion; 15 cents a word if a box number address care of any of our offices is used.

Proposals, 40 cents a line an insertion.

INFORMATION:

Box Numbers may be in care of our New York, Chicago or San Francisco offices.

Discount of 10% if full payment is made in advance for four consecutive insertions of undisplayed ads (not including proposals).

DISPLAYED—RATE PER INCH:

1 to 3 inches.....$6.00 an inch
4 to 7 inches.....5.75 an inch
8 to 14 inches.....5.50 an inch

Other spaces and contract rates on request.

An advertising inch is measured vertically on one column, 3 columns—30 inches—to a page.

FOR SALE

AIR KING, OX-5, bargain. New last August. Completely reconditioned. All new landing gear. Eligible for license. Never crashed. Fly away. $1,600. Monarch Aircraft Industries, Rockford, Illinois.

AMERICAN EAGLE, almost new, with Anzani 120 hp. motor. Ship and motor had 120 hours, motor 10 hours since complete factory overhaul. Two Scintilla mags., compass, booster and many other extras. Will sacrifice for $2,750 on quick cash deal. John Herfurtuer, 452 Willoughby Ave., Brooklyn, N. Y. Telephone Williamsburg 5596.

CLEAR DOPE, 1 gal. $1.75; Clear Dope, 5 gal. each $1.50; shock cord ¼ in. wide, 18c.; wing tape, 2 in. wide, 3½c. Miller valve actions $78. Supreme propellers $88. Quick service. The Auto-Equip Co., Rocky Mount, N. C.

FOR SALE: Hisso Standard J-1, with dual controls, ready to fly away. Motor in good condition. Model A, Hisso motor, 150 H.P. For quick sale $750.00. Public Service Station, Dunn, N. C.

FOR SALE: One 60 hp. LeBlond and one 35 hp. Anzani engine. Also have number of 60 hp. Velie M-5 engines, purchased on large contract. Having now adopted 90 hp. engines as standard on our Golden Eagle airplanes, we are willing to sell these smaller engines, which are all new, at reduced prices. Golden Eagle Aircraft Corporation, 415 East Industrial Avenue, Inglewood, Calif.

FOR SALE, LS-5, Wright E Hisso, 180 hp., turns 1,900, a real buy at $2,250, can be licensed or will trade for Travel Air. Also J-1, Hisso Standard, 150-A, $1,200; both ships now flying and in excellent condition. Leo Time Airport, Tiffin, Ohio.

FOR SALE, Jennie with high lift wings, all new covering, less motor. Leach Bros., Towner, N. D.

FOR SALE, Travelair demonstrator, 20 hours, $2,600; Waco ten, same as new, $1,825; Eagle Rock, excellent condition, $1,675. Will give ten hours instruction free to purchaser of either plane. 1359 First National Bank Bldg., Detroit, Mich. Cadillac 8892.

FOR SALE, Waco 10 OX-5, fully equipped, ship and motor in excellent shape, $1,900. Drewes Brothers, 43 Clifton Place, Jersey City, N. J.

FOR SALE, 1928 Waco 10, like new, equipped with new J-5 Wright Whirlwind motor. Instruments front and rear cockpits. Price, $5,200. Flyaway. Ronald McCuaig, 109 South La Jolla St., Los Angeles, Calif.

FOR SALE, sport light plane complete, flyaway. Also fuselage, rudder, propellors; light plane parts. Can be seen anytime. FS-157, Aviation, Tenth Ave. at 36th Street, New York.

FOR SALE: Brand new OX-5, run ten hours. Turns 1,400. Complete with Detroit Pneumatic starter. $1,000 cash. Starter costs $300 alone. The Bird Wing Commercial Aircraft Co., St. Joseph, Missouri.

Hisso-A $450. Complete, like new Curtiss C-6-A $950. Hisso Hand Starter $45. Wood Pontoon for light plane $35. M.F. uncovered Rudders and Horiz. Stabilizers $20 each. Used OXX cylinders $5 each. OX5 hand starters $10. C-6-A parts.

New Haven Air Terminal Inc.
P. O. Box 919, New Haven, Conn.

MOTOR

Absolutely sound licensed Challenger, 11 months, 150 hours, new Merryloid, newly rebuilt motor, Thompson valves, Miller rockers, Monoid propellor, parachute, seat, $2,300.

G. M. CROSS
184 Ward Street, Newton Center, Mass.

FOR SALE

FOR SALE: Licensed OX-5 Swallow, A-1 condition, motor rev., 1,420 ground. Price $2,250. Never been damaged. H. J. Joseph, 1603 8th St., Milwaukee, Wis.

FOR SALE: OX-5 Clipper-Wing Standard, in flying condition. Less motor, propeller and tachometer. $375. Stewart Abdella, 26 North St., Gloversville, N. Y.

FOR SALE: S.V.A. Biplane, new, 200 hp. L-6 motor. Props, tires, cable and covering new. Perfect condition throughout. $1,000. Eric Hanson, 4025 Sheridan Ave., Detroit, Mich.

FOR SALE: 50 OX-5 motors. Some rebuilt, like new, rest "as is." Price range $300-$500. FS-164, Aviation, Tenth Ave. at 36th St., New York.

FOR SALE: Practically new Hisso E Eaglerock; special color combination. FS-137, Aviation, Tenth Ave. at 36th St., New York.

FOR SALE: 1928 transcontinental Class "B" Race Winner. John H. Livingston's tapered wing Waco J-5 Wright. This ship is in perfect condition, 120 hours time, equipped with Aero Landing Struts, brakes and special complete instrument board and dual controls. An exceptional buy at $6,000. Mid-West Airways Corporation, Waterloo, Iowa.

FOR SALE: N. B. OX-5, Standard J-1, good wood and covering; motor just overhauled. $900. Lorix Halin, Sogswell, North Dakota.

FOR SALE—Fast plane (135 m.p.h.), for cross country work. Oriole fuselage, special built Sikorsky wings. New 180 Hisso motor. Whole job just repainted. $3,000. W. I. N. Strong, The Moorings, Nyack, N. Y. Phone Nyack 1687 before 10 a.m. best.

FOR SALE: Whirlwind J-5 Travel-Air biplane. Latest model equipped with flares and landing lights. Has had only four hours in the air and is practically new. $7,350 takes this ship which sells new for more than $9,000. Address replies to Oliver L. Parks, c/o Parks Air College, Inc., Box 681, East St. Louis, Ill.

—Twenty— Liberty Motors

Unassembled .....$200.00 each

For schools (not to be flown) slightly damaged, enough used parts to build a complete Liberty twelve cylinder motor with exhaust manifolds, propeller hub, and hand starter, $200 each.

For airplanes and motor boats enough used parts in good condition to build a complete Liberty twelve cylinder motor with exhaust manifolds, propeller hub and hand starter, $250.

Enough good used parts to build Model "A" Hispano, $400.

Enough used parts to build Model "E" Hispano, for flying, $550.

Model "H" Hispano assembled in fine shape, $200.

Salmson Nine Cylinder Radial less one magneto, $125.

Liberty Stub Tooth gears per set, $40.

Hand Starters "Liberty," $5.

Liberty Carburetors, $10.

We carry a complete line of Curtiss D12, Liberty, Mercedes parts as well as Observation Balloon Outfits, Search Lights, Power Plants for Search Lights, most any type magneto desired, and a large stock of new Model "E" Hispano motor parts, as well as tires, wheels, instruments, gas and oil tanks, and radiators for most any type ship or motor.

Rosenfield Aircraft Co.
College Park, Maryland
Mail Address P.O. Box 65, Mt. Rainier, Md.

FOR SALE

FOR SALE: Anzani, 70-80 hp. 6 cyl. radial, air cooled motor. Serial No. 5473. Complete with hub, propellor and complete set of spare parts, first-class condition. American Aeronautical Corporation, Whitestone, L. I.

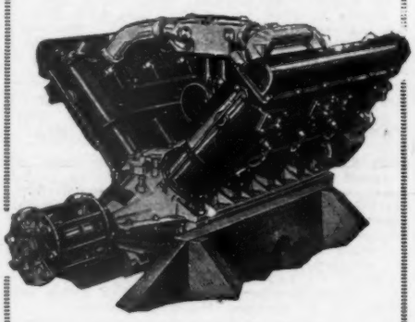
FOR SALE: Brand new Hisso A, Eaglerock delivered from factory July 3, 1929; perfect condition; ship is absolutely new and not damaged; special, three thousand dollars. FS-166, Aviation, 520 No. Michigan Ave., Chicago, Ill.

Flying Field and Equipment

For sale, located 2 miles east of Macomb, Ill., at junction of Routes 3 and 9 and on direct line between Chicago and Kansas City. Main hangar 80 x 50. Machine shop 30 x 20. Field contains 40 acres. More obtainable. All level for miles around. Also 1 Swallow OX-5 and 1 Jenny OX-5. Reason for selling, death of owner. J. F. Pearce, Macomb, Ill., R. 2.

FOR SALE—One OX-5 Curtiss motor. A-1 condition. Will sell at a bargain. W. O. Harlow, Kalamazoo, Michigan.

Not Often and Once More



Not often do you have the opportunity of purchasing 300 hp. Wright Engines like this, in new condition for $300, and **once more** will this advertisement appear at this ridiculous low price. Also one Government overhauled 150 hp. Hispano-Suiza with Stromberg carburetor, complete $600. These motors carry tags signed by Government Inspectors attesting to the fact that they have successfully passed block test.

KARL ORT, YORK, PA.

USED PLANES FOR SALE

These planes represent surplus equipment resulting from the consolidation of the various organizations making up the undersigned corporation. All are in excellent condition and ready to fly away. Any airplane listed here will be delivered within a radius of 500 miles from its location. Planes subject to prior sale.

Name of Airplane	Type	Open or Cabin	No. of Persons	Ship No.	Motor No. of Hours	Ship Time	Price as is F.O.B.	Location
Monocoupe	Mono.	Cabin	2	C6923	40 hr. Velie	35 hr.	$1,500	St. Louis
Monocoupe	Mono.	Cabin	2	C6538	60 hr. Velie	55 hr.	$1,500	Minneapolis
Curtiss-Robin	Mono.	Cabin	3	C7497	31 hr. OX-5	37 hr.	$3,400	Minneapolis
Curtiss-Robin	Mono.	Cabin	3	C7507	21 hr. OX-5	70 hr.	$3,500	Minneapolis
Waco 10	Bi.	Open	3	C6939	New OX-5	New	$2,500	St. Louis
Standard J-I	Bi.	Open	2	.....	Overhauled OX-5	New	$1,500	St. Louis
Ryan	Mono.	Cabin	5	C958	30 hr. W. W. J5	400 hr.	$4,800	St. Louis
International	Bi.	Cabin	6	C3266	90 hr. W. W. J5	90 hr.	$4,500	St. Louis
Lockheed Vega	Mono.	Cabin	6	NC7953	125 hr. Wasp	120 hr.	$17,500	St. Louis
Ryan	Mono.	Cabin	5	C3423	50 hr. W. W. J5	250 hr.	$6,500	St. Louis
Cessna	Mono.	Cabin	4	NC6442	126 hr. W. W. J5	111 hr.	$7,000	St. Louis
Fairchild	Mono.	Cabin	5	C4441	80 hr. W. W. J5	75 hr.	$7,000	St. Louis
Curtiss-Robin	Mono.	Cabin	3	C124E	20 hr. OX-5	18 hr.	$3,400	St. Louis
Ryan	Mono.	Cabin	5	C4654	125 hr. W. W. J5	275 hr.	$5,000	Oklahoma City
Ryan	Mono.	Cabin	5	C1787	Reblt. W. W. J5	500 hr.	$5,500	Oklahoma City
Lockheed Vega	Mono.	Cabin	5	C7426	Reblt. W. W. J5	250 hr.	$8,000	Minneapolis

Department W-7

UNIVERSAL AVIATION CORPORATION

Robertson Division

USED PLANE DEPT.

N639

Lambert-St. Louis Airport, Anglum, Missouri

FOR SALE

FOR SALE, two genuine Wright E. One 80 Hissos in good condition. One with Hamilton high-speed prop and hub, $650. One with new Curtiss-Reed prop., $750. Bosch Boosters with each motor. FS-169, Aviation, 520 No. Michigan Ave., Chicago, Ill.

FOR SALE, Swallow OX-5, dual control, 3 place Hartzel propeller. Practically new. 1383 Matthews Ave., Cleveland, Ohio.

FOR SALE: Waco 10 center section tank, air speed meter compass, motor turns 1,425 r.p.m. on ground fine contour, licensed C. 3087 M. FG. Co. number 783. Never been cracked. Sacrifice $1,895. H. Kohlert, Nash Garage, 100 Prarie St., St. Charles, Ill.

J-1 STANDARD—Motor and ship excellent condition. C-1402. New longerons and entire ship newly re-covered last year. For quick sale $850. C. M. Stevens, Neodesha, Kansas.

JENNY with OX-5 motor mount, less motor, in first-class shape, $300.00. Little-Greiner Flying Service, Inc., Springfield, Ohio.

LAWSON Biplane, Hisso powered, seventy-five hours, 150 hp. No time since complete overhaul. $1,200. Will sell motor. K. F. Miller, Marblehead, Mass.

FOR SALE

NEW OXX-6 motors in original boxes, very reasonable price. Will ship with privilege of inspection. Grant Marine Motor Company, 2625 St. Clair Ave., Detroit, Mich.

OX-JENNY, fuselage and empennage, rebuilt and recovered center section and main tanks. No splices in spars. "C" license the past year. Priced reasonable. Sidney P. Fowler, Route 1, Keosauqua, Ia.

OX-5 WACO nine, licensed, duals, motor in fine shape, ship kept in hangar. G. O. Imm, Fergus Falls, Minnesota.

PARACHUTES, new and used, rope ladders for stunt men, etc. Specify weight. Thompson Bros. Balloon and Parachute Co., Aurora, Illinois. Established 1903.

PITCAIRN-OROWING ready for demonstration, priced at $1,500, for quick sale. Miller Corporation, New Brunswick Airport, New Brunswick, N. J. Telephone 4392.

RYAN Brougham B-1, Wright JSCA, absolutely in first-class condition, always kept in hangar, 145 hours, $7,000 cash. Need money. FS-145, Aviation, 520 No. Michigan Ave., Chicago, Ill.

FOR SALE

Airport For Sale

Well equipped field located one mile south of Ames, Iowa, and Iowa State College, on the busiest road in the state. New pavement opening August 15. Steel hangar. Electric lights. Runways graded, rolled and seeded. Gas pumps in position. Parking space for cars. Excellent opportunity for student training, passenger work, sales and service. Write for details. Joe V. Gerbrach, Ames Theatre Co., Ames, Iowa.

Wright Whirlwind Five, 165 H.P. Engine

32 hours in air in Verville Air Coach under care of expert Wright mechanics. We are standardizing on Whirlwind-Seven. Price $2200 f.o.b. Detroit.

Verville Aircraft Co.

7424 Melville Ave., Detroit

CLOSING OUT

2—Berling D-81 Magnetos, new production, unused.

1—Berling D-81 Magneto, used only 5 hours, perfect.

3—Berling D-81 Breaker Assemblies, 2 new, 1 used slightly.

50—Mosler Spark Plugs, new, heavy type metric, unused.

1—Lot of OX5 Parts, almost all new, some used only 5 hours, perfect, market price of the lot $168.84.

1—Hoof Guide and Valve Replacement Outfit, complete jigs, reamers, drills, etc., with ½ in. Van Dorn, 5,700 heavy duty, 110 electric drill outfit, for OX5 and OXX6, never used, cost $215.

1—Lot of 22 new and slightly used Aircraft Instruments, all perfect except one glass cracked. Altimeters, switches, gauges, air speed gas pump boosters, tachometers, etc. at least $250 worth at market prices.

Will sell the whole works as listed for $250; can be inspected. Will not sell separately.

Rhode Island Air Service, Box 115, Hillsgrove, R. I.

MOTORS

A number of new OX5 Motors priced for immediate sale $750. Also a number of OXX6 motors at $800 f.o.b. Wichita or Detroit. Address

AVIATION ADVERTISING CO.

604 Schweiter Bldg., Wichita, Kans.

WANTED

AIRPLANE SALESMEN

by one of the oldest Airplane Companies in United States. Applicant must be seasoned, well trained to sell dealers and assist them in building business. Must be pilot. Apply

AVIATION ADVERTISING CO.

604 Schweiter Bldg., Wichita, Kans.

FOR SALE

SACRIFICE: Monocoupe Velie M-5 demonstrator, perfect condition, special lacquer paint job, motor turns 1,950 with Harztel prop, Pioneer compass, etc. A real buy at $1,600. Will deliver in California for expenses. J. L. Cousins, 865 Post St., San Francisco, Calif.

SIEMENS-HALSKE 5 cylinder radial, overhauled, OX-5 and OXX-6 motors; toothpick and saber blade propellers; wheels, tires and other material; 39-B ships and spares. L. M. Robb, Parkesburg, Pa.

WACO 10 powered with 125 Siemens engine, never crashed, two hours since motor completely rebuilt at factory. Ship flown less than 100 hours. Private used and always kept in hangar. Price $4,000.00. A. S. K., 2600 Delaware Ave. S. E., Minneapolis, Minn.

EQUIPMENT WANTED

WANTED—Complete set of wires for 1927 Air King. Leach Bros., Towner, N. D.

WANTED to buy parts and old OX-5, Curtiss engines, also any other brands. Will also accept trade in on old planes for new Travel Air planes. Silver Fox Air Lines, P. O. Box 61, Muncie, Indiana.

WANTED, used Soto, 45 hp., air-cooled motors. State full particulars and lowest price. Frank Sugent, Illinois Power Co. Garage, Springfield, Ill.

WANTED—Aircraft motors and parts, unfit for flight, for use in ground school, any condition of motor will be of use. No rotarys wanted. Send details and price to M. J. Hughes, 871 Seventh Street, Buffalo, N. Y.

POSITIONS VACANT

DRAFTSMEN, layout men and detailers with several years' aircraft experience. Excellent opportunity for men with experience and ability. Keystone Aircraft Corporation, Bristol, Pa.

EXECUTIVES, flying instructors, instructors of mechanics, etc., needed at once to join me in the Springfield School of Aviation. This is a real opportunity to get in on the ground floor and grow with a real organization. Write or wire the Springfield School of Aviation, 1417 East So. Grand Ave., Springfield, Illinois. Some investment required. Give full details in first letter: experience, etc.

TRANSPORT pilot wanted to fly Waco 10. Fifty-fifty proposition. H. Hinneburg, Northwestern Ohio Airport, Bryan, Ohio.

WANTED: Transport pilot as instructor. Reference required as to character and ability. P-168, Aviation, 520 No. Michigan Ave., Chicago, Ill.

POSITIONS VACANT

WILL employ a limited number of young men with grade school education. While learning to fly, good pay. Apply at once. 1359 First National Bank Building, Detroit, Michigan.

POSITIONS WANTED

PILOT, transport permit, 26, married, good references, 330 hours of barnstorming and student instruction, desires immediately connection with operation company or individual preferred. Available now, go anywhere. PW-152, Aviation, 520 No. Michagin Ave., Chicago, Ill.

JOB wanted; limited commercial pilot; 55 hours solo. Age 24; references, resonable salary; married. Will go anywhere. H. Hale, 6242 S. Green St., Chicago, Ill.

LATEST design welded steel tubing sport plane fuselage, includiing tail assembly, with tubular controls, manufactured by Government licensed mechanics, complete with rust proof coating inside and out, carefully crated for $198.00, or will manufacture to your specifications if desired. H & H Fuselage & Motor Co., 2903 Mt. Vernon, Ft. Worth, Texas.

LIMITED commercial pilot desires flying position. Will fly anywhere. Graduate of Pitcairn Flying School. Will supply letters as to character and ability. J. C. Foltz, Pitcairn Aviation, Inc., Willow Grove, Pa.

LIMITED commercial pilot wishes position. 115 certified hours, cross country experience. Now flying. References on request. PW-160, Aviation, 520 No. Michigan Ave., Chicago, Ill.

TRANSPORT pilot, 500 hours, instruction, passenger, cross country, some sales experience, located New York state. PW-165, Aviation, Tenth Ave. at 36th St., New York.

YOUNG man, married, wants a steady position as operations manager and pilot. Am licensed mechanic, 1,000 hour pilot. Can fly any open job. Prefer to instruct. Desire permanent connection with any good all year around firm. Have been an airplane mechanic for sixteen years. Can handle men and am a go-getter. Have operated shops, flying schools and passenger services. Am at present engaged as service manager for large New York Aircraft firm. Have a good instruction ship of my own. I absolutely do not use liquor. What is your offer? PW-158, Aviation, Tenth Ave. at 36th Street, New York.

UNLICENSED pilot, sixty hours, experienced in cross country and all weather conditions. Will go anywhere. References. J. C. Everett, 3520 Cherry St., Kansas City, Mo.

POSITIONS WANTED

UNLICENSED pilot, 400 hours, five years' storming experience; never cracked a ship. Good mechanic. Wants to fly unlicensed plane. PW-167, Aviation, 520 No. Michigan Ave., Chicago, Ill.

BUSINESS OPPORTUNITIES

EXPERT propeller designer and builder wishes connection with party interested in manufacture of aero-propellers, metal and wood. Have samples ready for test. BO-162, Aviation, Tenth Ave. at 36th St., New York.

Partner Wanted

To buy plane costing between $1,500 and $2,000. To fly from Roosevelt Field. BO-163, Aviation, Tenth Ave. at 36th St., New York.

Small Flying Field

With hangar, shop and all stock and equipment. Price comparatively small. BO-161, Aviation, Tenth Ave. at 36th St., New York.

MISCELLANEOUS

ATTENTION Aviators: Valve guides installed on OX cylinders, $1.50 per guide; removable valve seats installed, $1.00; descriptive literature upon request; all work guaranteed. Illinois Flying Co. New location, 4 West 4th St., Sterling, Ill.

MACHINE shop service on OX-5's. Cylinders reground, new pistons, pins and rings. Graphite guides and inserted seats installed. Oversize pins installed in valve actions. Main and connecting rod bearings line reamed. All work guaranteed. New OX-5 parts. Write for complete circular. Heckman Machine Works, 4026 West Lake St. Chicago, Ill.

Learn Welding

LEARN WELDING and lead burning in the best equipped school in St. Louis; day and evening instruction; no classes; each student has unlimited personal instruction; no time limit. Full course on all the common metals, including aeronautical tubing; only $100. Get your money's worth. Aeronautical Engineering Company, 2903 Shenandoah Ave., St. Louis, Mo.

AVIATION—Salary while learning, $18 to $35 per week, while under instruction in our factory and shops. Call or write for information without obligation. AERO CORPORATION OF AMERICA, Department AV. 63 Second Street, Milwaukee, Wisconsin.

PATENTS—TRADE MARKS

Don't Lose Your Rights To Patent Protection
Before disclosing your invention to anyone send for free blank form **"EVIDENCE OF CONCEPTION"** to be signed and witnessed.

LANCASTER & ALLWINE
Registered Attys.
421 Ouray Bldg., Washington, D. C.
Originators of forms "Evidence of Conception"

***Attention* Godfrey Jorkovich**

It is a matter of the utmost importance to you that you communicate immediately by telegraph with Julian Schuster, Ontonagon, Michigan.

JULIAN SCHUSTER

When you want men—

Put your advertising for them on the same basis as your other publicity.

If you want a pilot, aeronautical engineer, expert repairman, or other competent assistant, an advertisement in the Searchlight Section of *Aviation* will put you in prompt touch with the best men available. The cost is only 10 cents a word. Send in your advertisement today for the next issue.

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NATION WIDE

KINNER

5 CYLINDER - 100 HORSEPOWER

KINNER AIRPLANE AND MOTOR CORP.
GLENDALE, CALIFORNIA

THANK YOU *for mentioning* AVIATION

TWO YOUNG PILOTS AND ONE "WHIRLWIND"

A FEW weeks ago the single-motored "Fort Worth" raised two enthusiastic, but unknown young aviators, to world fame. By the comfortable margin of nearly twenty-two hours, they had broken all existing endurance flight records.

One of the youthful pilots was a 21-year old cow puncher from the wide ranges of Texas. The other, at the age of 26, had been first a railroad mechanic, and then a flier "on his own."

Their Mahoney-Ryan had been reconditioned and altered by themselves to suit their purposes. And the Wright "Whirlwind" engine they used was "second hand" and had already run for over 500 hours before they started this flight. If the propellor hadn't given way under a heavy hailstorm they might have continued flying indefinitely, for another week, perhaps longer!

When the cracked propellor compelled them to land they had covered, without interruption, a little more than half the distance around the world. And every cylinder in the "Whirlwind" motor was functioning perfectly . . . on the job . . . after 172 hours of continuous flying!

The world stood astounded. The Wright Corporation, although highly gratified, was not amazed at this performance. For a stock "Whirlwind" engine simply showed what it could do—that Wright engines keep on running.

WRIGHT

AERONAUTICAL CORPORATION

PATERSON, NEW JERSEY